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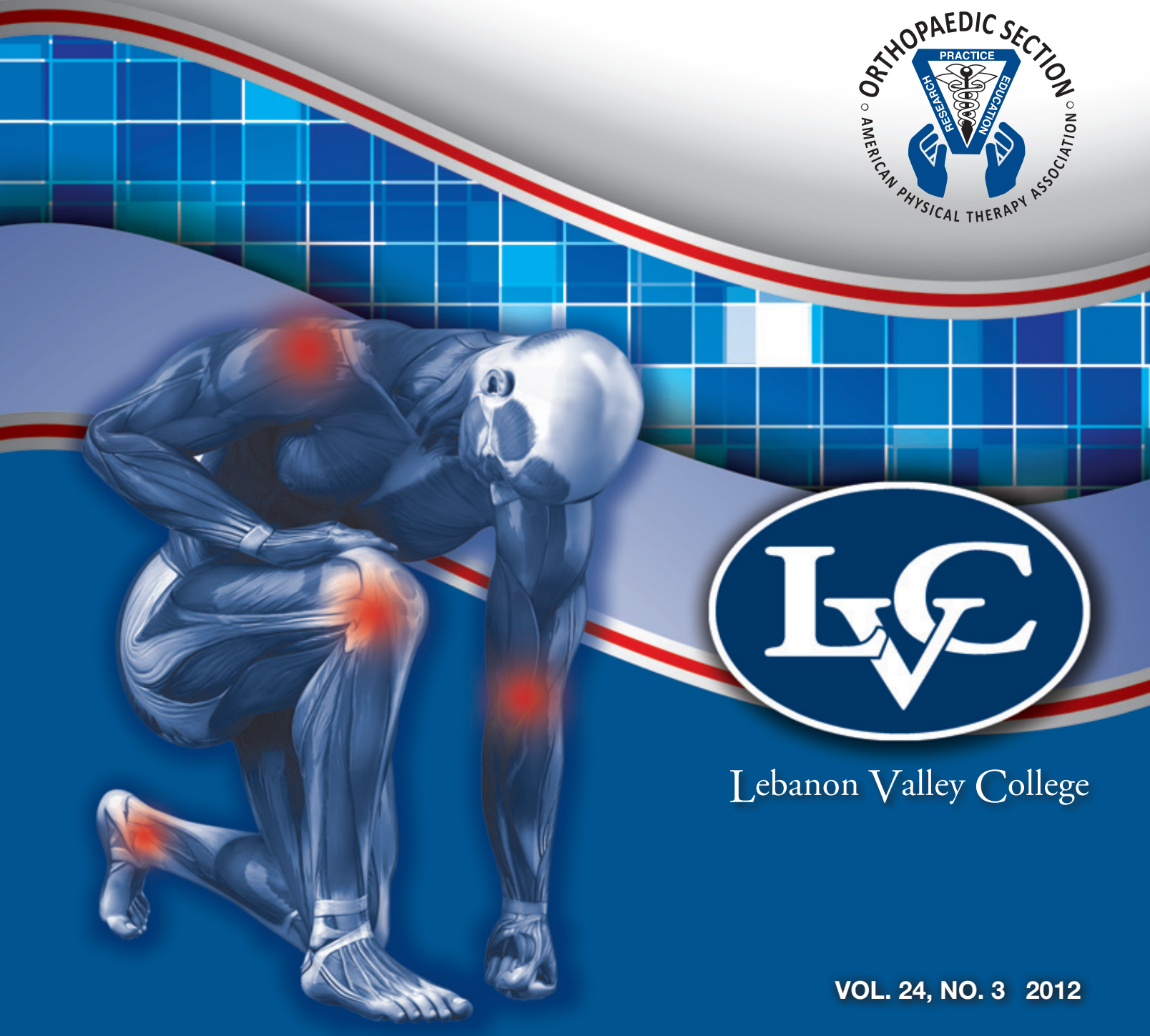

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In this issue

Regular features

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To serve as an advocate and resource for the practice of Orthopaedic Physical Therapy by fostering quality patient/client care and promoting professional growth.

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Editor's Note

Déjà vu All Over Again!

Christopher Hughes, PT, PhD, OCS

The last time we published a faculty student research issue lead faculty member, Steven George and the University of Florida filled two issues [Vol. 22(2), 2010 and Vol. 20(4), 2008]. Once again I am pleased to report that another academic program, Lebanon Valley College has chosen to answer my call. Dr Michael E. Lehr, PT, DPT, OCS, CSCS, was instrumental in coordinating the effort with us as was Dr Michael Fink, PT, DSc, SCS, OCS. In this issue, Dr Lehr and Dr Fink along with selected students from Lebanon Valley College present 6 research initiatives on topics ranging from the use of a clinical prediction rule and clinical practice guidelines for managing a patient with hip pain to a literature review of reverse total shoulder arthroplasty versus shoulder hemiarthroplasty in patients with rotator cuff arthropathy. I applaud the efforts of these students for "getting in the game" and attempting to take the didactic knowledge that they learned in the classroom and apply it to clinical practice. Furthermore, I appreciate the students' willingness to share their efforts with the readers of *Orthopaedic Physical Therapy Practice*. Finally I echo Dr Lehr's sentiment and his special recognition of Dr Nelson as well as all of the faculty at Lebanon Valley College for trying to produce the best clinicians possible. As always, we continue to invite other programs to submit their work.

Lebanon Valley College

Guest Editorial

Michael L. Fink, PT, DSc, SCS, OCS
Michael E. Lehr, PT, DPT, OCS, CSCS

Dr Roger Nelson

As assistant professors in Lebanon Valley College's Doctoral Physical Therapy program, we have had the unique privilege of working alongside and being mentored by one of the physical therapy profession's great leaders. As an individual who has significantly impacted the physical therapy profession for over 4 decades, he has become our role model. As an author and scholar, this forerunner has contributed over 50 peer reviewed journal publications and two textbooks in the areas of orthopaedic physical therapy and electromyography. As a visionary, this man chaired key committees charged with developing the *Guide to Physical Therapist Practice*. As an advocate for life-long learning, he was instrumental in developing the first accredited Clinical Electrodiagnosis Residency in 2011. As an educator, he has been an invited guest speaker nationally and internationally for numerous organizations. And having a heart for underserved populations, he has devoted time to coordinating and providing pro bono educational services through the United States Public Health Service over the last 17 years. His list of accomplishments is many, not the least of which was being recognized as a Catherine Worthingham Fellow of the American Physical Therapy Association in 1997. Most recently he was selected to deliver the upcoming 44th Mary McMillan Lecture at PT 2013. In an attempt to thank this man for his many years of distinguished service, leadership, and personal mentorship, we dedicate this issue of *Orthopaedic Physical Therapy Practice* to Roger M. Nelson PT, PhD, FAPTA, Professor Emeritus faculty at Lebanon Valley College.

Roger, we sincerely thank you for your years of unwavering service and your exemplary leadership to the physical therapy profession. The Lebanon Valley College Physical Therapy Department thanks you for your passion, guidance, and commitment to excellence within the evidence-based critical inquiry course series in the entry-level doctoral physical therapy program. We consider you not only a colleague but a treasured friend who has provided us with the vision of how evidence-based practice can elevate the physical therapy profession within the current value-based health care environment. We owe you so very much for what you have already taught us and we look forward to future opportunities to learn from you. Thank you Dr Nelson!

With Great Admiration,
Michael L. Fink, PT, DSc, SCS, OCS
Michael E. Lehr, PT, DPT, OCS, CSCS
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The Use of an Impairment-based Treatment Program to Improve the Sit-to-Stand Task Following Total Knee Arthroplasty: A Case Report

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At the time of the case, A. Willow was completing her entry level Doctorate of Physical Therapy at Lebanon Valley College. The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or reflecting the views of Lebanon Valley College.

ABSTRACT

Background and Purpose: The total knee arthroplasty (TKA) has been found to be a safe and effective means of providing relief and improving function in individuals with osteoarthritis upon failure of conservative treatments. **Methods/Case Description:** The patient was a 68-year-old male status-post right TKA 4 weeks, who presented with significant activity limitations secondary to impairments of the lower extremity. **Findings/Interventions:** The patient was systematically progressed using an impairment-based treatment program that was comprised of isolated range of motion and strengthening exercises to the lower extremity, and neuromuscular re-education training. **Clinical Relevance/Outcomes:** Outcomes were assessed for the most meaningful impairments of the lower extremity. The patient reported a 90% functional improvement and demonstrated an improved ability to perform functional tasks, specifically the sit-to-stand task. The patient's lower extremity functional scale score had improved from 27/80 at initial evaluation to 54/80 upon discharge. **Discussion/Conclusion:** This case report demonstrates how a treatment plan designed to address key impairments commonly seen in patients status-post TKA, can successfully progress a patient toward their rehabilitation goals.

Key Words: total knee arthroplasty, sit to stand task, functional training, neuromuscular re-education

BACKGROUND

Osteoarthritis is a chronic joint disease that results in the degradation of the cartilage, synovial tissue, and bone at major joints in the body.[1,2] The prevalence of osteoarthritis increases with age and becomes much more common after age 50.[2] Knee osteoarthritis, one of the most common forms, was found to affect 53% of women and 33% of men over 80 years old; however, the incidence is constantly rising due to the ageing baby-boomer population and the current obesity epidemic.[2,3] Individuals with knee osteoarthritis often experience severe joint pain, strength, and range of motion impairments,[4] which lead to serious functional limitations such as gait[4] and stair negotiation[5] deficits. These activity limitations cause patients to experience difficulty with daily activities such as home and community mobility, household chores, and work responsibilities.[6] Consequently these activity limitations may result in a decreased quality of life.[4]

Prior to surgery, physicians often attempt to relieve the pain and disability caused by knee osteoarthritis using medications and lifestyle modifications; however, many patients do not respond to these methods.[2] The total knee arthroplasty (TKA) has been found to be a safe and effective means of providing relief and improving function in individuals with osteoarthritis after failure of conservative treatments.[1] While this procedure was originally reserved as a last resort to relieve the pain and improve function in very old patients, improved technology and surgical results have led to a growing increase in demand for arthroplasties among older patients and younger patients (< 65 years old) alike.[1-3] A recent study by Kurtz et al[3] predicted that this increase in desire, combined with the increasing population age and other factors would lead to an increase in number of TKAs from 59,077 in 2006 to 994,104 by 2030.[3]

Considering the current health care environment and given the significant number of individuals who undergo TKAs each year, efficient and effective rehabilitation of these patients is a primary concern to physical therapists. While research indicates that many patients return to preoperative status following rehabilitation, a distinct disparity has been found between functional levels of those status-post TKA and healthy age-matched peers, despite postoperative physical therapy.[4] Research has found considerable variability in physical therapy interventions, number of visits, and patient outcomes following TKAs.[4,6,7] Consequently, study participants who received physical therapy in the community, rather than receiving a standard intervention protocol, received a lower value of care. Inconsistency in number of visits and nature of treatment was cited as the cause of this outcome variation.[4] In the current health care environment, which necessitates high value of care, there is a clear need to eliminate this inconsistency between outpatient rehabilitation protocols for TKAs and determine the most effective and efficient interventions that will achieve the most optimal patient outcomes.

In order to analyze the effectiveness of physical therapy interventions in addressing activity limitations, appropriate outcome measures can be used. Researchers have used a wide variety of self-report,[5] range of motion,[4,8] strength,[4,8,9] function,[4,8,9] and quality of life measures.[4,9] The primary concern of physical therapy following a TKA is to improve a patients' ability to perform necessary aspects of daily mobility such as standing, walking, and stair climbing.[6] Numerous studies investigating improvements following TKAs have used some variation of the sit-to-stand task as a functional outcome measure.[4,5,7-10] Nyland et al[5] found that a patient's ability to perform a chair-rise was closely correlated with adequate

strength and range of motion necessary to safely begin stair-climbing.

Many studies have correlated reduction of body structure impairments, such as increasing quadriceps or hip abductor strength, to improved ability to perform the sit-to-stand task.[9,11,12] In a recent study by Mizner et al,[11] 40 subjects who had recently undergone a unilateral TKA, were enrolled in a physical therapy program that emphasized quadriceps strengthening in open and closed kinetic chain exercises progressing to functional activities. The results of this study found a significant correlation between increased quadriceps strength and improved functional ability.[11] Piva et al[13] expanded on the previously mentioned study by examining the relationship between both quadriceps and hip abductor strength and functional ability in a patient two to 6 months after a TKA. Researchers found that while there was a significant correlation between combined strength of the muscle groups and functional ability to perform tasks such as the sit-to-stand, hip abductor strength alone was more significantly correlated with functional improvement than quadriceps strength.[13]

While these studies correlated improvements in body structure impairments to improved ability to perform the sit-to-stand task, they did not examine the specific movement patterns used to perform this motion. It should be noted that research on patients who had TKAs has shown poor performance on the sit-to-stand task defined by the patient demonstrating compensatory movement patterns.[10] In a study of 35 asymptomatic individuals, Burnett et al[14] found that the sit-to-stand task was performed with completely symmetrical biomechanical and kinetic motions between bilateral lower extremities. Christiansen et al[15] also found asymmetrical weightbearing during sit-to-stand transfers to be correlated to limitations in functional mobility. In addition, movement patterns that increase reliance on the nonoperated lower extremity, can increase abnormal forces through the contralateral knee and result in the need for an additional TKA.[15] A study by Farquhar et al[16] examined the effects of 6 weeks of physical therapy treatment, with an emphasis on quadriceps strengthening, on the ability to perform the sit-to-stand task. A variety of functional tests, strength measurements, and motion analysis were used to determine patient status at 3 months and one year after a unilateral TKA. While quadriceps strength and performance on functional measures increased over this time period, patients continued to use significantly different movement patterns to perform the sit-to-stand task when compared to controls. These results indicate that while lower extremity strength is correlated to improved function, specific movement retraining may be necessary to allow patients to return to normal, symmetrical performance of the sit-to-stand task.[16] To this end, clinicians should focus on the patient's quality of the movement during neuromuscular re-education, as well as the sit-to-stand task.

Limited research has been conducted on neuromuscular re-education for patients following TKAs; however, multiple studies have shown the benefits of this treatment approach to alter movement patterns in different populations.[7,11,17] In a study of 18 female college basketball players, Chapell and Limpisvasti[18] used a force plate and 3D motion analysis to observe movement patterns during a drop jump and vertical stop jump. Significant changes in movement patterns were found following a 6-week neuromuscular re-education program.

Given the significant number of patients who undergo TKAs each year and the clinical variability in physical therapy management following this procedure, a clear consensus on the most effective treatment approach can benefit clinical practice patterns within the profession. A compilation of current research suggests the need for a comprehensive physical therapy program that addresses strength impairments, specifically of the hip abductor and quadriceps muscle groups, in combination with neuromuscular re-education to restore symmetrical movement patterns.[18]

The purpose of this article is to describe the physical therapy management of a 68-year-old male who recently underwent a right (R) TKA revision and to determine and prioritize the most valuable interventions, which would encourage an optimal return to function.

CASE DESCRIPTION

Examination: History

The patient was a 68-year-old male who was one month status-post (s/p) R TKA revision and 5 days s/p R total hip arthroplasty (THA) revision upon initial evaluation. He is a retired school teacher and lives with his wife in a ranch home with one step to enter and one flight of stairs to the basement. He has one daughter and a grandson who live nearby. His hobbies include working outside, riding his lawn tractor, babysitting his grandson, going boating with his family, and working in his garage. The patient had a significant past surgical history as well as multiple co-morbidities. His past surgical history included an original R TKA 10 years ago (secondary to osteoarthritis), and two previous R THA revision surgeries that occurred 4 and 5 years ago. Patient's co-morbidities include history of osteoarthritis, elevated cholesterol, high blood pressure, and heart disease. He also had a history of smoking although he had not smoked in the past 5 years. His current medications included Furosemide, Quinapril, Pravastatin Sodium, Omeprazole, and "various pain medications" reported by the patient.

The patient had received physical therapy for 3 weeks directly following his R TKA revision, and was progressing well, but was discharged prior to receiving his R THA revision and was being re-evaluated for continued rehabilitation of his R knee. Rehabilitation of his R hip was to be initiated at a later date upon clearance from the patient's surgeon. Due to his extensive history of multiple joint replacements, the patient was well aware of the course of physical therapy and motivated to participate. He reported that he felt physical therapy was responsible for getting him moving in the past, but indicated that he had not been performing any of the home exercises he was given (prior to his THA). He also stated that he had lost a significant amount of the motion, strength, and function gained prior to his surgery.

Patient reported his primary activity limitations included the following: moderate difficulty with walking despite use of rolling walker, unable to climb stairs, and maximal difficulty rising from a chair. He reported that his inability to rise from a chair or to bend down to play with his 3-year-old grandson were his primary concerns at this time. He indicated that his goals at the time of initial evaluation were to: (1) have decreased pain in his right leg, (2) be able to bend down to play with his grandson, (3) be able to move well enough to repair his boat, and (4) go on a family vacation in one month.

Examination: Tests and Measures

Pain

Pain intensity was recorded using a 10-mm visual analogue scale where a rating of 0 indicated no pain and 10 indicated the worst pain ever experienced. The patient reported his pain level at the time of the initial evaluation was 3/10; however, he reported that he had taken pain medication

prior to physical therapy. He indicated that his pain at worst was a 5/10. This rating was reached when he did not take his pain medication and attempted to bend his knee.

Sensation

As the patient had no prior history of sensation loss, only a brief assessment for awareness of light touch was performed for bilateral (B/L) lower extremities. Sensation was intact B/L.

Active range of motion

Knee and ankle active range of motion (AROM) were assessed using standard goniometric measurement. Active knee flexion was measured with the patient in supine and found to be 5°-102° on the R and 1°-130° on the left (L). Active ankle motion was also measured in supine and found to be within functional limits B/L.

Strength

Strength was assessed using a standard break test. The patient sat with B/L lower extremities over the edge of the mat. To assess knee extension, the patient was asked to extend each knee and to hold the position as the physical therapist applied resistance. The amount of resistance the patient was able to sustain prior to flexing his knee was then graded numerically (maximal resistance 5/5, near maximal resistance 4+/5, moderate resistance 4/5, minimal resistance 4-/5, able to maintain position against gravity 3/5, etc.). Right knee extension was 4-/5 and L knee extension was 4+/5. Flexion was measured in the same position but the patient was asked to prevent the therapist from straightening his knee. Right knee flexion was 4/5; L knee flexion was 4+/5.

Observational gait analysis

Patient was able to ambulate independently with the use of a rolling walker. He demonstrated significant antalgic gait on the R lower extremity (LE) and decreased R stance time. Presence of a R Trendelenburg gait was also noted.

Observational sit-to-stand analysis

Patient required increased time to sit down in a chair and performed a L weight shift while doing so. He placed his hands on the armrests of the chair with increased weightbearing through his upper extremities during the transfer. Patient was able to stand up from a chair independently with maximal difficulty and asymmetrical weightbearing. When performing the sit-to-stand task, he placed most of his weight through his L LE and B/L upper extremities (UEs). He required a significant amount of time to perform the transfer and reported an increase in knee pain. Patient demonstrated mild loss of balance upon initially removing his hands from the arm rests of the chair but was able to self-correct.

Lower Extremity Functional Scale

This self-report measure was used to indicate the patient's perceived level of functional limitation due to his recent TKA. His score was 27/80 upon initial examination.

The results of the clinical exam were consistent with an individual who had recently undergone a TKA revision. The patient demonstrated increased R knee pain and limited R knee ROM compared to the L. He also demonstrated weak quadriceps and hamstrings on the R compared to the L LE. Although not tested due to hip pain secondary to the patient's recent THA revision, the patients R Trendelenburg gait pattern also indicated weakness of the hip abductors on the L side. The previously mentioned impairments resulted in the patients maximal difficulty with the sit-to-stand task and were consistent with the patient's self-reports of difficulty performing this activity. The role of the patient's recent R THA revision and increased difficulty with the sit-to-stand task was acknowledged; however, the focus of the present case was on clinically meaningful impairments related to the TKA.

EVALUATION/DIAGNOSIS/ PROGNOSIS

Clinical Decision Making

Based on the examination findings, an impairment-based diagnosis was determined, which included right knee mobility and stability deficit. A plan of care was developed emphasizing this diagnosis and the patient's activity limitations. Prognosis was determined to be good pending compliance with his physical therapy program and also his previous experience in a successful physical therapy regimen, and current motivation level. Considering the patient's presentation, clinically meaningful impairments, and current evidence, a plan of care was designed to address his current and long-term functional needs.

INTERVENTION

The patient attended therapy 3x/week over a 4-week period for a total of 12 sessions. The treatment plan consisted of modalities as needed, manual physical therapy, and therapeutic exercise progressions.

Modalities

As the patient reported significant R knee pain that tended to increase following physical therapy interventions, electrical stimulation (interferential current) was applied to the R knee combined with a cold pack during the first 6 treatments. As pain progressively decreased, no modalities were used during the last 6 sessions.

Manual Physical Therapy

Due to the patient's significant limitations in R knee flexion and extension ROM, passive ROM, and stretching into knee flexion and extension with the patient in a supine or supine with trunk elevated on a wedge position were administered initially. Stretches were maintained for 30 seconds and usually performed 3 to 5 times for each motion as indicated by increased ROM limitation.

Exercise Prescription

Heel slides

The patient was again positioned in supine with a pillow case over his right foot. He was instructed to actively slide his heel across the mat to a position of maximal knee flexion; this position was held for 5-10 seconds. The total motion was repeated 10 times initially and progressed to 30 times. Progression was determined by the patient's reported pain and fatigue during the exercise. As the patient was limited in knee flexion ROM, this exercise allowed the patient to actively move the limb to end range flexion and progressively increase motion at the joint.

Quad sets

The patient was positioned supine on the mat with a small bolster directly behind his knee. He was instructed to contract his quadriceps muscle in an attempt to straighten his knee and push down into the bolster. Patient began with 2 sets of 10 contractions at the initial evaluation and was able to progress to 3 sets of 10 contractions by the second visit. This exercise was used to initially strengthen the quadriceps muscle and to provide an extension stretch without provoking increased knee pain/irritation.

Short arc quads (SAQ)

The patient was placed supine on the mat with a large bolster under his knee. His knee was bent to 90° over the bolster at rest, and he was asked to actively straighten his knee. Initially this exercise was performed 10x without weights; however, the number

of repetitions (up to 30) and ankle weights were progressed throughout treatment. Progression was again based on the patient's reports of pain and fatigue, as well as an observation of the patient's movement pattern and apparent level of effort.

Long arc quads (LAQ)

The patient was seated at the edge of the mat with both legs resting at 90° over the mat. The patient was asked to straighten his knee. Initially this exercise was performed 10x without weights; however, the number of repetitions (up to 30) and ankle weights were progressed based on observation of perceived effort and the patient's reports of pain/fatigue. Rationale for this exercise is the same as the previously mentioned exercise. This motion allowed for early strengthening of the quadriceps muscle without provoking significant pain/discomfort.

Standing knee flexion

The patient stood holding on to a bar and was instructed to bend his R knee as far as possible and then lower it. This exercise was progressed from 10 repetitions to 30 repetitions and ankle weights were added and progressed. Progression was again based on the patient's reports of fatigue, pain, and observed level of effort. Limitations in knee flexion ROM, hamstring strength, and hip abductor strength were addressed with this motion. The single leg stance (SLS) position assumed throughout the motion required the patient to balance on his contralateral lower extremity and he was instructed to prevent his pelvis from dropping to the active side.

Straight leg raise

The patient was positioned in supine with his non-operated knee bent to 90° and his foot flat on the mat. He was asked to contract his quadriceps muscle and lift the involved limb until it was parallel with his uninvolved leg, then slowly lower his leg back to the mat, while keeping his knee as straight as possible. The patient was asked to perform 10 reps of this motion initially, as the patient's perceived level of effort decreased, repetitions were progressed up to 30. This exercise, similar to several previous exercises, was designed to increase quadriceps strength, but also incorporated strengthening the hip flexor muscles.

Bridges

The patient was positioned in supine with both knees bent to 90° and feet flat on the mat. The patient was instructed to perform an abdominal brace (isometric contraction of his inner abdominal musculature) while slowly lifting his pelvis off the mat until a straight line was achieved between his knees and his shoulders. He then slowly lowered to the starting position. This exercise was initially performed 10 times but was progressed (according to previously mentioned criteria) up to 30 repetitions. This exercise was designed to strengthen the patient's core, hamstrings, gluteus maximus, and hip abductors.

Mini-squats

The patient stood with his feet shoulder width apart holding on to a bar for support. He was instructed to lower into a squatting position, maintaining his knees behind his toes. The patient lowered approximately 45° and then returned to upright. This was performed 10x initially, but was progressed to up to 30 repetitions according to patient tolerance. This exercise achieved quadriceps, hamstring, and hip abductor strengthening in a functional standing position. This exercise also encouraged the patient to increase symmetry of weightbearing between his L and R lower extremity.

Sit-to-stand

The patient started from a seated position in a chair (initially the chair had two arm rests however the patient progressed to a chair with no arm rests prior to discharge). The patient was instructed on an appropriate technique to lean forward and rise from the chair, bearing weight equally through each LE. Initially, the patient was allowed to use his UEs to push up from arm rests, but was instructed to rely on UE support as little as possible. Eventually the patient was instructed to fold his arms across his chest during sit-to-stand. Patient performed 3 sit-to-stand repetitions initially and progressed, according to patient tolerance, up to 20 repetitions. Table 1 provides a summary of exercise prescription used in this patient.

Home Exercise Plan

The patient was provided with a home exercise plan (HEP) beginning on the first day of treatment and progressed until discharge. The initial HEP consisted of passive knee bends (the patient was instructed to sit with R LE outstretched, wrap a towel around his R foot, and passively pull his R foot toward him to reach maximal knee flexion), seated hamstring stretch (same position as previous, patient was instructed to maintain

Table 1. Summary of Exercise Prescription

Total Knee Arthroplasty Revision Exercises

Visit Initiated	Exercise	Maximal Repetitions	Rationale
1	Heel Slides	3 sets of 10 reps	Increase knee flexion active range of motion
1	Quad Sets	3 sets of 10 reps	Increase quadriceps strength
1	Short Arc Quads	3 sets 10, 7 lbs	Increase quadriceps strength
2	Long Arc Quads	3 sets 10, 8 lbs	Increase quadriceps strength
3	Standing Knee Flexion	3 sets 10, 8 lbs	Increase knee flexion active range of motion Increase hamstring strength Increase balance Increase hip abductor strength
5	Straight Leg Raise	3 sets 10	Increase quadriceps strength Increase hip flexor strength
6	Bridges	3 sets 10	Increase hip abductor strength Increase core stability Increase hamstring strength
8	Mini-Squats	3 sets 10	Increase quadriceps strength Increase hip abductor strength Promote symmetrical weight bearing Enhance static standing balance
9	Sit-to-Stand	20 repetitions	Increase quadriceps strength Increase hip abductor strength Promote symmetrical weight bearing and quality movement during sit-to stand task

Table 2. Summary of Pre- and Post-testing of Examination Findings

	Initial		Final	
	Right	**Left**	**Right**	**Left**
Pain				
Knee	3-5/10	0/10	0/10	0/10
Range of Motion				
Flexion	5º-102º	1º-130º	2º-135º	0º-130º
Extension (seated)	102º-5º	130º-1º	135º-2º	130º-0º
Strength				
Flexion	4/5	4+/5	5/5	5/5
Extension	4-/5	4+/5	4+/5	5/5
Lower Extremity Functional Scale (LEFS)	**27/80**		**54/80**	

a straight leg and pull his R LE off the bed until a stretch is felt in the posterior knee), and a quad set (as previously described). This combination of exercises allows maintenance of knee flexion/extension ROM and quadriceps strength gains made during physical therapy sessions. Additional exercises, including LAQs, mini-squats, and sit-to-stand, which were progressively added to this program approximately one session after they were initiated during rehabilitation. The patient was gradually progressed from isolated therapeutic exercises and techniques to more integrated dynamic movements that replicated his functional movement needs.

OUTCOMES

Re-evaluation each week revealed gradual improvements in pain rating, ROM, and strength as measured by self-report, goniometric measurements, and break testing. Improvements were gradually noted in functional abilities as well. At 10 days after initial evaluation, the patient was able to ambulate with a straight point cane, and required less time to rise from a chair, although he continued to report moderate difficulty with both of these activities. Also, the patient continued to exhibit moderate difficulty with both of these activities, however, continued to exhibit moderate asymmetrical weightbearing (left > right) during the sit-to-stand task and to demonstrate a moderately antalgic gait with occasional R Trendelenburg.

Four weeks after his initial evaluation, and 7 weeks after his R TKA revision, the patient reported his pain intensity to be 0/10 in his R knee. Right knee flexion AROM improved to 2°-135° and was actually greater than L knee flexion ROM, which remained 0°-130°. His knee flexion strength increased to 5/5 B/L and his knee extension strength increased to 4+/5 on the R and 5/5 on the L. Table 2 provides a summary of initial and final examination findings for pain, range of motion, and strength.

Upon final examination, the patient's LEFS score had improved to 54/80 from 27/80 reported at the initial evaluation. The patient reported he was experiencing minimal difficulty with ambulation without an assistive device, was able to perform stair climbing with moderate difficulty, and indicated minimal reported difficulty with the sit-to-stand task. An observational gait analysis revealed the patient was able to ambulate with increased weightbearing on the right lower extremity with no assistive device. Observational analysis of the sit-to-stand task also confirmed the patient's subjective reports as the patient demonstrated improved weight shift to the R during the transfer, was able to stand without using his UEs, and required less time to perform the task.

The patient was discharged at this time and was provided with a continued HEP including mini-squats, the sit-to-stand task, and heel slides to maintain full functional ROM, strength, and ability to perform quality functional movements with his R LE. A follow-up call was made to the patient one month after discharge and he reported he had been able to go on vacation with his wife, daughter, and grandson. He reported experiencing minimal difficulty with prolonged walking, and with performing the sit-to-stand after prolonged periods of sitting, but was otherwise able to fully participate in family activities.

DISCUSSION

Impairments in strength, muscle activation, and performance of functional activities, such as the sit-to-stand task are common in patients who have recently undergone a TKA.[4] The goal of physical therapy following this procedure is to allow patients to return to quality functional performance of necessary daily activities. The patient in this case exhibited increased pain and decreased strength that were contributing to his limited functional ability to rise from a chair and participate in activities with his family. The importance of this case report lies in the progressive interventions provided to the patient following his TKA revision and the patient's response to these interventions, especially his improved ability to perform the sit-to-stand task.

The present case illustrates that not all patients will fit every aspect of a protocol. This patient, for example, had undergone a THA revision several days prior to initiation of rehabilitation for his previous TKA revision, which necessitated some alterations in treatment selection and time of treatment implementation. However, a criterion-based protocol in combination with clinical judgment will help to reduce current practice variability and potentially improve overall value of care for a patient status-post TKA.

Current research has focused on eliminating impairments such as quadriceps[19] and hip abductor[13] weakness. While strength improvement in both muscle groups alone are correlated to functional improvements[12,13] with the hip abductors showing a significantly greater correlation to function, Piva et al[13] found that combined improvements had the greatest correlation to functional ability in several areas, including the sit-to-stand task. This research suggests the importance of addressing both quadriceps and hip abductor strength during rehabilitation following a TKA.

Strength impairments in both of the previously mentioned muscle groups were addressed in this case. Consistent with the literature, this case report prioritized quadriceps and hip abductor strengthening to improve the sit to stand task.[12,13,19] Most daily activities, including rising from a chair involve motion at multiple lower extremity joints and consequently require muscular strength to produce active knee extension as well as hip extension and stability in the frontal plane.[26] As the quadriceps femoris muscle is mainly responsible for knee extension,[13] it is reasonable to assume that strength in additional lower extremity

muscle groups is necessary to promote quality functional movement.[13]

Although improvements that correlated with increased strength were noted in our case, the specific interventions used to achieve those improvements should be noted. While isolated open kinetic chain exercises were used initially, the patient quickly progressed to closed kinetic chain exercises such as squats and eventually the sit-to-stand task. A similar strengthening program that consisted of progressive strengthening exercises for the quadriceps, hip abductor and hamstring muscle groups, as well as functional activities, was used in the study by Mizner et al.[12] Following participation in this protocol, researchers found that patients achieved superior functional outcomes compared to those in other reported studies and participants' scores were similar to those of norms recorded for healthy age-matched peers.[12]

One limitation of the Mizner study[12] includes the fact that although the exercise protocol included interventions designed to enhance strength in a variety of lower extremity muscle groups, only quadriceps strength was measured and correlated to functional improvements. Consequently, the role of improved strength in other muscle groups on the outcomes of the study is unknown. In addition, while isolated quadriceps strengthening exercises were used throughout the study, the specific interventions performed by participants also included integrated closed kinetic chain exercises and functional activities.

Another related study, by Farquhar et al,[16] found that despite increased strength in the quadriceps muscle group, patients who had undergone a TKA continued to use abnormal movement patterns (asymmetrical weightbearing) to perform the sit-to-stand task when compared to healthy subjects. This study supports the assumption that functional neuromuscular exercises, such as the specific sit-to-stand task that was used in our case study, are necessary for the patient to return to quality functional performance of daily activities. A study by Yoshida et al[9] examined the relationship between increased quadriceps strength and recovery from TKA. While a correlation was found between functional improvements and increased quadriceps strength, functional retraining of specific tasks was necessary for optimal recovery.[9] The findings of the present case study, support the importance of neuromuscular re-education exercises and progressive strengthening to improve quality performance of the sit-to-stand task following a TKA.

At the time of the case report, the patient had already undergone a total of 6 joint replacement or joint replacement revision surgeries on his R lower extremity. Consequently, protecting his contralateral lower extremity, and avoiding the need for future surgeries was a heightened priority in this patient. It should be noted that research has found that healthy subjects perform the sit-to-stand task with bilaterally symmetrical movement patterns and muscle activation.[14] Additionally, asymmetric movements have been linked to increased stress on the non-surgical limb that may result in osteoarthritis and possibly the need for an additional joint replacement surgery in the contralateral lower extremity.[15,19]

No studies have currently been conducted on the ability of neuromuscular re-education to alter movement patterns in patients following a TKA specifically. Recent research in college athletes however, has shown that biomechanics and kinetics of knee motion can be altered using neuromuscular re-education.[18,20,21]

Filipa et al[20] provides additional evidence of the effectiveness of neuromuscular re-education in improving movement patterns of college athletes.[20] Researchers found that participation in a neuromuscular training program including core stability, lunges, single-leg-stance, and jumping activities improved balance performance in 13 soccer players when compared to 7 control subjects.[20] An additional study by Bruin and Murer[7] examined the effects of a standard strength training program, and a program that included strengthening in addition to neuromuscular balance exercises, on dynamic postural stability, quadriceps strength, and functional measures, including the chair stand test, in a group of individuals residing in a senior living community. Results of this study found that subjects in the combined strength and balance training group showed significantly greater improvements in all functional measures. Specifically, older subjects who underwent a combined neuromuscular training program focusing on progressive balance exercises demonstrated significant improvements in the performance of the sit-to-stand task compared to those who participated in strength training alone.[7]

The results of this case were consistent with those of other studies mentioned here and provided further evidence of the benefits of neuromuscular re-education in patients s/p TKA. While the patient in this case exhibited functional improvements as a result of standard strengthening exercises (quad sets, long arc quads, straight leg raises), his greatest improvements were in his ability to perform the sit-to-stand task in an efficient manner.

This case demonstrates that the implementation of a standard impairment-based protocol for rehabilitation of patients following TKA, which includes progressive strengthening exercises as well as functional neuromuscular re-education exercises, has the potential to improve the value of physical therapy interventions for these patients.[1,17,25] In health care, value is typically defined as decreased resource utilization in combination with improved outcomes. A criterion and time-based protocol, in addition to clinical judgment, can help to eliminate variability in physical therapy management for patients who have undergone a TKA. Additionally, as was found in this case, implementation of neuromuscular re-education exercises can lead to faster improvements in patients' ability to perform these necessary tasks, as well as increased quality of movement patterns during task performance. Common activities of daily living are preceded by the ability to stand up from a seated position.[24] By improving the quality of movement by which patients perform activities such as the sit-to-stand, physical therapists may also be able to limit stress on the contralateral joints and possibly help to prevent future osteoarthritis and associated pain and functional limitations in these patients. Future studies should focus on continuing to identify and prioritize the most meaningful impairments that should be addressed in a comprehensive treatment program for a patient s/p TKA.

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The Use of a Clinical Prediction Rule and Clinical Practice Guidelines to Manage a Patient with Hip Pain: A Case Report

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At the time of the case, J. Fisher was completing his entry level Doctorate of Physical Therapy at Lebanon Valley College. The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or reflecting the views of Lebanon Valley College.

ABSTRACT

Background and Purpose: Osteoarthritis (OA) is the most common arthritic disease in the United States. Osteoarthritis affects 10% to 25% of the population over the age of 55, and is a common pathology treated by physical therapists. **Methods/Case Description:** The patient was a 64-year-old female initially referred with a diagnosis of left lumbar radiculopathy and bilateral hip pain. Current evidence was used to determine the probability of an accurate diagnosis of hip OA. **Findings/Interventions:** Based on this diagnosis, a rehabilitation program was developed to address the patient's activity limitations. **Clinical Relevance/Outcomes:** The patient demonstrated improvements in clinically meaningful impairments, such as hip range of motion (ROM) and overall function with a perceived improvement of 90% since initial visit. **Discussion/Conclusion:** This case report describes how a doctoral physical therapy student applied clinical reasoning tools to assist in determining a differential diagnosis in a complex patient.

Key Words: hip osteoarthritis, clinical prediction rule, clinical practice guidelines, differential diagnosis

BACKGROUND

Osteoarthritis (OA) is the most common arthritic disease in the United States, typically affecting 10% to 25% of the population over the age of 55.[1] The prevalence of OA increases with age, hence it is likely to become more prevalent as the baby boomer generation grows older.[1] A commonly proposed theory for describing the pathology suggests that joint integrity is altered from repetitive and biomechanical stresses.[2,3] In addition, genetics is also believed to play a role in the development of OA.[2] Physical therapists can use the current literature to enhance clinical decision making and treatment for this condition.

Patients with OA typically report pain that worsens with weightbearing activities and improves with rest.[4] Many individuals with OA also experience morning stiffness.[1] These patients typically have difficulty with various functional activities, such as ascending and descending stairs, sit to stand transfers, and weightbearing activities.[4] Some additional activity limitations cited in the literature include rising out of bed, performing sit-to-stand transfers while sitting, and getting on/off a toilet.[5-9] In addition over 85% of patients with OA reported at least moderate difficulty ambulating on flat surfaces. In the same population, almost 73% of the patients reported a decreased ability to participate in social activities.[7,10] Once a patient's activity limitations are identified, a clinician can perform the appropriate tests and measures that quantify the most meaningful impairments.

Decreased hip strength and range of motion are common impairments associated with hip OA.[2] Both of these impairments can directly affect activity limitations in patients with OA of the hip and knee.[1,7] Similarly, research has shown that decreased ROM was associated with high levels of both self-reported and observed disability.[7]

Diagnostic criteria for hip OA have evolved significantly from the early 1990s to the present day.[1,4,11] In 1991, the American College of Rheumatology (ACR) published an article that established classification criteria for patients with hip OA.[4] The ACR's classification model was based on two models of classification criteria: one involving clinical criteria alone, and one involving clinical criteria along with radiographic information.[4] In terms of the model involving only the clinical criteria, a patient was diagnosed as having hip OA if pain was present in combination with either: (1) hip internal rotation ≤ 15°, pain present on internal hip rotation, morning stiffness of the hip ≤ 60 minutes, and age > 50 years, or (2) hip internal rotation <15° and an erythrocyte sedimentation rate (ESR) ≤ 45mm/hour; if no ESR was obtained, hip flexion ≤115° was substituted.[4] The clinical classification model resulted in 87% sensitivity and 89% specificity for accurately determining patients with hip OA.[4] Conversely, the model that includes clinical plus radiographic criteria combines hip pain with at least two of the following 3 criteria: osteophytes (femoral or acetabular), joint space narrowing (superior, axial, and/or medial), and ESR < 20 mm/hour.[2,3] The combined model yielded an 89% sensitivity and 91% specificity.[12,13] One similarity between the ACR's two models is limited hip internal rotation ROM.[14] Restricted hip internal rotation has been shown to be the most predictive of radiographic hip OA when compared to all other hip movements.[15,16] Conversely, hip flexion was determined to be the least predictive.[15] In a 1998 study, Cyriax's capsular pattern of the hip was indeed found to be invalid in patients with hip OA.[17]

Sutlive et al[1] in 2008 established a clinical prediction rule (CPR) for individuals with hip OA that included 5 components: (1) self-reported squatting as an aggravating factor, (2) active hip flexion causing lateral hip pain, (3) positive Scour test with adduction causing lateral hip or groin pain, (4) active hip extension causing pain, and (5) passive internal rotation of the hip ≤ 25°.[1] The greater the number of predictor variables present, the greater the likelihood of an accurate diagnosis of hip OA.[1] For example, if ≥ 3 of 5 predictor variables are present, the likelihood of the subject having radiographic hip OA increased from 29% to 68%.[1] Fur-

thermore, if ≥ 4 of 5 predictor variables are present, the likelihood of the subject having radiographic hip OA increased from 29% to 91%.[1] Although this CPR should be considered during the clinical decision-making process with patients with hip OA, the rules should not be viewed independent from the Orthopaedic Section, APTA Clinical Practice Guidelines for Hip OA.

According to the Orthopaedic Section, APTA Practice Guidelines,[11] the following clinical criteria are typically present in individuals who have radiographic findings consistent with hip OA: (1) reports of moderate pain in the lateral or anterior hip with weightbearing that may progress to the anterior thigh or knee region, (2) age > 50 years old, (3) limited passive ROM of the hip joint in at least two of the 6 directions, and (4) morning stiffness that improves in < 60 minutes. These practice guidelines integrate factors from both the ACR's clinical criteria as well as the CPR for hip OA.[11]

While radiographs are the accepted gold standard for diagnosing OA, x-rays result in increased patient visits, increased health care costs, and increased risk to the patient. By establishing patterns of clinical findings consistent with patients with hip OA, clinicians should feel sufficiently confident of an accurate diagnosis, and thus minimizing the use of radiographs. In order for musculoskeletal management of these patients to be efficient in today's health care marketplace, the clinician must establish an accurate and timely diagnosis.[11]

The purpose of this case report is to describe how the evidence can be used to assist the novice clinician in arriving at a diagnosis in a 64-year-old female that presents with hip pain. Additionally, the case report demonstrates how a doctoral physical therapy student with limited clinical experience can use available clinical decision making tools, such as CPRs and clinical practice guidelines in order to enhance their diagnostic ability.

CASE DESCRIPTION

Examination (History)

The patient was a 64-year-old female referred with a diagnosis of left lumbar radiculopathy and bilateral hip pain with insidious onset. The patient's chief complaint was a decreased ability to weight bear greater than 10 to 15 minutes without aggravating hip pain. She stated her pain had become so severe at times it had forced her to avoid ascending and descending stairs. The patient also reported difficulty with rising from a chair secondary to bilateral hip pain. The patient's past medical history (PMH) was unremarkable, except for the use of medication to control hypertension.

Table 1. McKenzie's Repeated Movement Testing

Flexion	100% peripheralization of symptoms into left posterior thigh, not extending below knee
Extension	75% with no change in symptoms
Right side-glide	100% with no change in symptoms
Left side-glide	100% with slight increase in pain from 2/10 to 4/10; localized to left low-back region

Pain and Activity Limitations

The patient reported experiencing 8/10 pain in R groin x 3 wks, occasionally radiating down anterior thigh, 6/10 pain in L groin x 3-4 months, and 4/10 pain in L) lumbar spine that radiated down posterior aspect of thigh, particularly with flexion-based activities. She had been experiencing low back pain intermittently for the last 1.5 years. Patient stated groin pain was varied as well and tended to be worse at the end of the day, when getting up in the morning, and after prolonged periods of weightbearing activity. Her bilateral hip pain, as well as L lumbar spine pain were exacerbated by weightbearing activities >15 min, ascending and descending stairs, and rising from a chair. The patient stated she had more difficulty descending stairs as opposed to ascending. Patient reported insidious onset of pain and stated that the groin pain had progressively increased to the point it had forced her to significantly cut back her work hours as a cashier at a grocery store. She described her groin pain to be located "deep in my groin area." She stated that about 80% of the time it was localized to her groin, but that occasionally she had a shooting sensation that began laterally and wrapped around to her anterior thigh, consistent with the lateral femoral cutaneous nerve distribution. She reported that this occasional shooting sensation was more noticeable on the right compared to the left. Patient goals were to decrease pain and resume occupational-specific activities for a full 8-hour day. Patient also reported she wanted to be able to resume walking and traveling with her husband, both of which were currently limited due to the pain and discomfort.

Examination (Tests and Measures)

Due to the patient's subjective complaints of low back pain and bilateral groin pain, the tests and measures administered for this patient focused on the lumbopelvic hip complex, as well as the lower extremity. The lower extremity was included in the examination initially due to the regional interdependence implications that could be impacting the patient's movement patterns. Furthermore since the patient reported radicular symptoms down the posterior, lateral, and anterior aspect of her thigh, an assessment to determine the integrity of the neuromuscular structures of the lower extremity was warranted. Table 1 shows the results of McKenzie's repeated movement testing used to assess the ROM and integrity of the patient's low back region. Table 2 shows the results of the patient's LE ROM and strength screen at the time of her examination.

Gait Analysis

Following these special tests, the patient was asked to walk for about 20' x 2 across the clinic to observe her gait pattern. The following gait abnormalities were noted: increased foot pronation bilaterally, toe-out on R lower extremity, and a slightly decreased step length on the left. Patient denied complaints of hip pain throughout any phase of the gait cycle. The patient's upper body was rather rigid with decreased arm swing and decreased trunk and pelvis dissociation.

Additional Special Testing

In addition to goniometric measurements, manual muscle testing, and McKenzie's repeated movement testing, the student physical therapist (SPT) performed various special tests to further identify meaningful impairments and muscle imbalances. The patient was found to have a (+) Scouring test bilaterally, (+) Thomas test bilaterally for iliopsoas and rectus femoris muscle length deficit, and a (+) Flexion, Abduction, External Rotation's (FABER) test bilaterally for hip pain. The patient also presented with a negative passive straight leg raise (SLR) test bilaterally and negative findings with sacroiliac (SI) joint testing that included anterior and posterior gapping tests, cranial and caudal shear tests, and sacral thrust.

Table 2. Passive Range of Motion and Manual Muscle Test Measurements at Initial Evaluation

Right Lower Extremity	Passive Range of Motion	Manual Muscle Test
Hip flexion	0°-112° with empty endfeel	3-/5 with pain
Hip extension	0°-13° with empty endfeel	4-/5 with pain
Hip abduction	0°-38°	4/5
Hip external rotation	0°-34°	4/5
Hip internal rotation	0°-18° with empty endfeel	2+/5
Knee flexion	118° - 0°	4/5
Knee extension	0°- 118°	4/5
Left Lower Extremity	Passive Range of Motion	Manual Muscle Test
Hip flexion	0°-105° with empty endfeel	2+/5 with pain
Hip extension	0°-12° with empty endfeel	4-/5 with pain
Hip abduction	0°-34°	4-/5
Hip external rotation	0°-38° with empty endfeel	4/5
Hip internal rotation	0°-13° with empty endfeel	2+/5
Knee flexion	112° - 2°	4/5
Knee extension	2° - 112°	4+/5

EVALUATION/DIAGNOSIS/PROGNOSIS

Clinical Decision Making

Based on the patient's clinical presentation, the sacroiliac joint was ruled out, and lumbar involvement was hypothesized to be a minimal contributor to the patient's pain and activity limitations. The clustering of meaningful clinical findings resulted in determining a diagnosis of hip osteoarthritis, which was deemed more appropriate based on current evidence. Four of the 5 clinical variables were met in the CPR previously described, which increased the probability of the presence of hip osteoarthritis to 91%.[4] Determining an accurate prognosis for this patient was challenging for the SPT due to the therapist's limited clinical experience and not knowing the extent of the OA.

INTERVENTIONS

Based on the operating diagnosis and clinically meaningful findings, a plan of care was developed to address the patient's needs and activity limitations. The interventions for this patient focused on addressing the patient's pain, decreased hip ROM, and decreased mobility and stability of the lumbopelvic-hip complex. Considering regional interdependence implications and the patient's functional movement goals, the treating SPT developed a manual- and exercise-based treatment plan for the affected body regions. Furthermore, specific interventions were selected to address the patient's goals for therapy including return to work for a full 8-hour day with no pain, ability to take pain-free walks, and being able to travel more frequently with her husband without the need for frequent breaks.

Manual therapy

Manual therapy techniques emphasized on increasing the patient's hip ROM to facilitate improved performance with activities of daily living (ADLs) and also to decrease pain. Manual interventions included: bilateral hip manual distraction, bilateral hip lateral glide, bilateral hip IR/ER PROM, and prone bilateral quadriceps stretch. In addition a sciatic nerve stretch was performed, which positioned the hip at 90º and knee at 90º, then knee extension was progressively increased until a desired stretch was obtained in the posterior leg.

Therapeutic exercise

Therapeutic exercise consisted of core stabilization exercises and ROM and strength exercises for the lower extremity (LE). Therapeutic exercises implemented into the patient's plan of care (POC) included: stationary bike, hip abduction, adduction, flexion, extension SLR in lying progressing to standing, bridging, standing backbends (BB), hook-lying hip abduction and adduction with ball and strap, single knee to chest (SKTC) and double knee to chest (DKTC), and lateral trunk rotations (LTRs).

Neuromuscular re-education/functional training

Neuromuscular re-education and functional training consisted of balance activities such as foam marching and single leg stance (SLS) on foam as well as the leg press machine to increase LE strength to facilitate ease with sit-to-stand transfers. The patient was also encouraged to walk in her neighborhood for increasing amounts of time to increase her cardiovascular endurance.

In order to progress the patient efficiently, the exercise volume and prescription were modified and progressed based on patient tolerance and response to treatment. Orthopaedic and motor control principles were applied to the treatment model. Exercise progressions incorporated a systematic approach to include isolated therapeutic exercises to more complex and integrated movements that resembled her previously described activity limitations.

Outcomes

The patient attended 22 sessions of physical therapy (PT). Upon discharge, she stated that she felt 90% better than when she initially came to PT. In addition to decreased pain and increased functional abilities, the patient also showed improvements in her previous clinical impairments. It should be noted that the lower extremity functional scale was not used with this case, which limited the pre- and post-functional measures. To this end, the SPT focused on self reported functional outcomes directly from the patient and incorporated these findings into the outcome analysis. At discharge, she was able to ambulate for up to 45 to 60 minutes without increased pain, able to ascend/descend a full flight of stairs without increasing back or groin pain, and able to perform a sit-to-stand transfer without increased pain. She reported that her bilateral groin pain at worst was 2/10, specifically when waking up in the morning and at the end of the day. She stated she was able to perform prolonged standing activities such as cooking with only "a slight discomfort" in her hips and low back.

In terms of posttreatment hip passive ROM, the patient exhibited within normal limits for flexion, extension, internal rotation, external rotation, and abduction. The most significant improvements were made with IR from 0°-18° on the right lower extremity (RLE) and 0°-13° on the left lower extremity (LLE) found on initial examination. Furthermore, the patient's knee flexion PROM at the time of discharge was 0°-133°

on the RLE and 0°-128° on the LLE. Table 3 provides a summary of the pre- and post-measures for hip ROM. In addition to her ROM gains, the patient was also markedly stronger at the time of discharge in terms of manual muscle testing. The patient's hip flexion strength increased from 3-/5 and 2+/5 respectively to 4-/5 bilaterally at the time of discharge. Furthermore, her hip IR strength increased from 2+/5 bilaterally to 4-/5 on the RLE and 4/5 on the LLE. Lastly, the patient's hip extension strength increased from 4-/5 bilaterally to 4/5 and 4+/5 on the LLE and RLE respectively.

Table 3. Hip Pre- and Post-range of Motion Measures

	PRE Right Hip Passive Range of Motion	POST Right Hip Passive Range of Motion	PRE Left Hip Passive Range of Motion	POST Left Hip Passive Range of Motion
Flexion	0-112	Within Normal Limits	0-105	Within Normal Limits
Extension	0-13	Within Normal Limits	0-12	Within Normal Limits
Abduction	0-38	Within Normal Limits	0-34	Within Normal Limits
External Rotation	0-34	Within Normal Limits	0-38	Within Normal Limits
Internal Rotation	0-13	Within Normal Limits	0-12	Within Normal Limits

DISCUSSION/CONCLUSION

The clinical diagnosis of hip OA is commonly made through a combination of subjective information and physical examination findings.[1,4,11] In terms of identifying subjective information consistent with OA, the patient in this case reported increased pain with weightbearing activities, performing sit to stand transfers, ascending/descending stairs, and standing for prolonged periods of time.[4] Furthermore she also reported significant morning stiffness localized to bilateral groin regions.[4]

In terms of physical examination findings, the patient presented with ROM deficits and functional limitations described in the hip OA literature.[1,7,18] The patient also fit into the classification criteria as defined by the ACR including hip IR ≤ 15°, pain with IR of the hip, morning stiffness of the hip ≤ 60 minutes, age > 50 years, and hip flexion ROM ≤115°.[4] Similarly, the patient presented with 4 of the 5 criteria consistent with the CPR for hip OA.[1] These findings included: (1) self-reported squatting as an aggravating factor, (2) active hip flexion causing lateral hip pain, (3) positive Scour test with adduction reproducing groin pain, and 4) passive IR of the hip ≤ 25°.[1] According to the CPR, one can be 91% confident of an accurate diagnosis of hip OA when 4 of the 5 factors are present in the patient.[1] However, the need for validation of the current hip OA CPR and classification criteria for hip OA still warrants further study.[1]

As a novice clinician attempts to meet the challenges of today's health care environment, he or she can use clinical decision making tools available in the current literature. As seen in this case report, regardless of whether the clinician is a novice or experienced clinician, the application of evidence may lead to effective patient care. With confidence in an accurate diagnosis, the novice clinician can appropriately develop a plan of care addressing the patient's needs and goals, thus potentially increasing the likelihood of optimally managing a complex orthopaedic patient.

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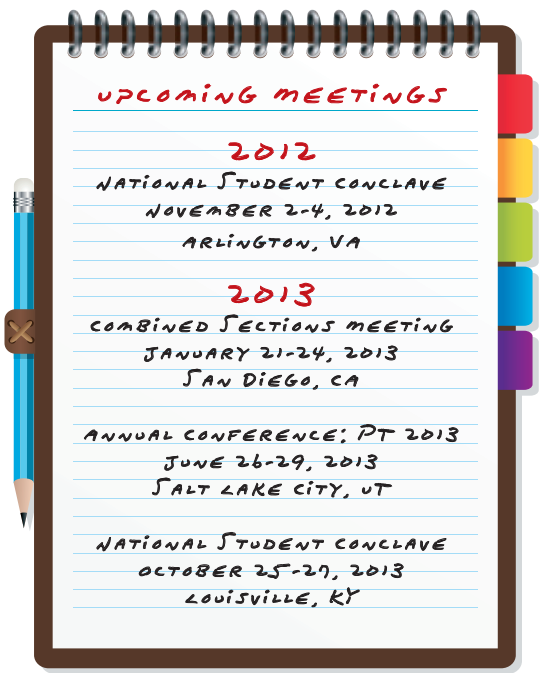

Clinical Application of the Classification System in the Musculoskeletal Management of a Patient with Chronic Neck Pain: A Case Report

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ABSTRACT

Background and Purpose: Ten percent to 20% of the population reports neck problems, with 54% of individuals having experienced neck pain within the last 6 months. In an attempt to enhance clinical practice and clinical reasoning, clinical practice guidelines and classification systems have been developed in order to integrate into clinical practice. **Methods/Case Description:** The patient was a 35-year-old male with a chief complaint of chronic neck pain with an activity limitation of decreased ability to perform occupational tasks. Patient exhibited consistent fear avoidance behaviors and decreased ability to relax during the treatment sessions. Based on the examination findings, the patient was classified in the conditioning classification. **Findings/Interventions:** The patient's plan of care consisted of a manual and exercise-based treatment approach appropriate for the conditioning classification assigned to this patient, which was progressed as tolerated. **Clinical Relevance/Outcomes:** This case report applies current evidence to a patient with complaints of chronic neck pain through the clustering of clinically meaningful impairments. **Discussion/Conclusion:** This case report describes how a doctoral physical therapy student applied the classification system in order to enhance her clinical reasoning skills to determine an appropriate diagnosis.

Key Words: neck pain, classification system, clinical reasoning, manual therapy, diagnosis

BACKGROUND

Neck pain continues to be a common musculoskeletal condition that orthopaedic physical therapists treat in the outpatient setting. In North America, the lifetime prevalence of neck pain is 66.7%, and it is estimated that 22% to 70% of the population will have neck pain at some time in their lives.[1,2] At any given time, 10% to 20% of the population reports neck problems, with 54% of individuals having experienced neck pain within the last 6 months.[2] Prevalence of neck pain increases with age and is most common in women around the fifth decade of life.[2] Rates of neck pain recurrence and chronicity are high.[3] Neck pain can last a few days to months to years and can be disabling in a small percentage of the adult population. This condition can pose major economic concerns related to increased health care costs, lost wages due to time off work, and companies having to incur compensation repayment.[4] Therefore, there is a need in finding an effective method of treatment, especially for chronic neck pain that leads to the majority of health care costs.[4]

Neck pain is multifactorial.[2,5,6] The origin of neck pain can be due to any of the following: a traumatic event such as whiplash from a motor vehicle accident (MVA) or sports collision, overuse of muscles, sleeping postures, excessive computer use, infection, tumor, osteoarthritis, and disc degeneration or disease.[6] Neck pain can also originate from improper biomechanics of the cervical spine, scapula, and/or shoulder complex, as well as poor postural habits. Although the origin of neck pain may be associated with degenerative processes or pathology identified during diagnostic imaging, the tissue that is contributing to a patient's neck pain is most often unknown.[2] Since a pathoanatomical cause is not identifiable in the majority of patients who present with complaints of neck pain and neck-related symptoms, a serious medical pathology (such as cervical fracture or myelopathy) is often ruled out first, in which patients with neck pain are then classified as having a nerve root compromise or a "mechanical neck disorder."[2] As a result, it is important for clinicians to identify the most meaningful impairments that can contribute to the patient's neck pain and activity limitations.

The ICD (International Statistical Classification of Diseases and Related Health Problems) categories include the following: cervicalgia, thoracic spine pain, headaches, cervicocranial syndrome, sprain/strain of cervical spine, spondylosis with radiculopathy, and cervical disc disorder.[2] Neck pain can manifest with many different signs and symptoms that can lead to clinical variability among physical therapy practitioners in terms of musculoskeletal management of this condition. The multifactorial complex condition of neck pain can result in range of motion limitations in the cervicothoracic spine, headaches, and refer pain to the upper extremities.[2]

Neck pain can be categorized into two types, acute and chronic. Acute neck pain is usually associated with a traumatic event such as whiplash whereas chronic neck pain is often associated with having an extensive history of neck pain, co-existing low back pain, and being older (> 40 year old).[2] Chronic neck pain is often more challenging to treat than acute neck pain because psychosocial factors (hypersensitivity, depression, worrisome attitude, poor quality of life, and less vitality or lack of motivation) have to be taken into account.[2] One study reported that 30% of patients with neck pain will develop chronic symptoms.[2] It is important for a clinician to identify whether neck pain is acute or chronic due to the evidence revealing that specific interventions are used depending on the chronicity of symptoms.

Treatment of neck pain and associated symptoms are often treated nonsurgically. Current literature suggests there is sufficient evidence to support conservative treatment interventions commonly used by physi-

cal therapists. Manual therapy techniques such as cervical/thoracic mobilization and thoracic spine thrust manipulation,[2,7-11,13-16,] stretching exercises,[2,8,18] different strengthening exercises,[2,4,9-11,13,17-20] and traction (both manual and mechanical)[2,9,11] are all common interventions for the treatment of neck pain. The treatment of neck pain often leads to a wide range of clinical approaches for addressing this condition. The clinical variability, which often exists during the management of this condition, can often lead to less than optimal outcomes within the profession. Thus, it is important to have clinical decision making tools to aid in the management of neck pain. In an attempt to enhance clinical practice and address the challenge of clinical variability for this complex condition, Fritz and colleagues proposed a classification system to integrate into clinical practice.[9,10] The classification system "clusters" meaningful clinical findings as it pertains to neck pain, as well as provides relevant patterns for the clinician to recognize within this patient population. Based on these patterns, specific "subgroups" with similar signs and symptoms can be identified within this patient population. To this end, subgrouping of these patients may enhance clinical decision making, and move the profession forward to standardizing care within the profession.

In order to guide the treatment of neck pain, a clinical prediction rule (CPR) was developed to identify a subgroup of patients who are more likely to benefit from early success of thoracic spine thrust manipulation since it is thought that hypomobility of the thoracic spine has a negative impact on movement of the cervical spine.[10] The 6 variables that make up this CPR include: (1) symptoms < 30 days, (2) no symptoms distal to shoulder, (3) looking up does not aggravate symptoms, (4) Fear Avoidance Behavior Questionnaire Physical Activity score < 12, (5) diminished upper thoracic spine kyphosis, and (6) cervical extension ROM < 30°.[10] This CPR is useful to treat patients with acute neck pain since evidence supports that thoracic spine manipulation reduces pain, disability, and perceived improvement in those patients with neck pain within 48 hours.[10] However, this CPR only takes into account symptoms lasting less than 30 days and does not take into account neck pain lasting longer than 30 days.[10] Therefore, finding the most appropriate interventions for treatment of chronic neck pain continues to pose a challenge to today's orthopaedic physical therapist.

Patients with neck pain are considered to be a heterogenous group, due to the multiple signs and symptoms that are related to neck pain. From this, subgroups have emerged from the classification system and have been identified by Fritz and Brennan,[11] in which proposed interventions are matched to specific subgroups with similar clinical presentations. With the ability to classify patients with neck pain, physical therapists may be better able to treat and determine a more suitable prognosis for the patient. Classification strategies also can increase the viability of clinical research, enhancing efforts to develop evidence that can favorably affect clinical practice by identifying evidence-based practice guidelines for particular subgroups.[11]

A proposed treatment-based classification system was examined for patients receiving physical therapy interventions for neck pain and found associations between receiving interventions matched to the system and better clinical outcomes.[11] These 5 classifications include: (1) mobility, (2) centralization, (3) exercise and conditioning, (4) pain control, and (5) headache.[11] The mobility classification supports the use of manual therapy such as mobilization and manipulation for patients who have decreased cervical or thoracic ROM and is most effective when used in combination with an exercise program.[11] The centralization category is based on centralizing radicular symptoms secondary to nerve root compression in which the use of traction and cervical neck retractions are the most effective interventions.[11] The exercise and conditioning category focuses on strengthening exercises of the neck and surrounding musculature in patients with persistent pain and with no radicular symptoms.[11] The pain control classification looks at using cervical ROM exercises and avoiding immobilization in patients with a significant amount of pain usually secondary to whiplash or some other traumatic event.[11] Finally, the headache classification looks at patients with cervicogenic headaches stemming from the cervical spine and recommends cervical mobilization or manipulation along with strengthening of the neck musculature.[11]

As previously stated, there are a variety of issues making the management of neck pain challenging for the clinician. These can include the plethora of signs and symptoms that develop because of cervical pain, the acuteness or chronicity of the pain, and the multiple activity limitations that may result. While most attention has been given to physical risk factors for neck pain, psychosocial risk factors also seem to play a major role in the development of neck pain.[5] Patients with neck pain (specifically chronic neck pain) can be depressed, lack motivation, and demonstrate fear-avoidance behaviors. These psychosocial issues can have an impact on clinical outcomes. A systematic review of psychosocial risk factors for neck pain showed that there is a positive relationship between neck pain and high quantitative job demands, poor social support, low job control, low skill discretion, and low job satisfaction.[5] It is important that clinicians take this evidence into consideration when developing treatment for patients with chronic neck pain. Table 1 summarizes the literature regarding treatment approaches and interventions for chronic neck pain.

The purpose of this manuscript is to emphasize how a novice clinician applied the classification system and practice guidelines in order to arrive at a diagnosis during the management of this patient. Based on the current evidence and clinical practice guidelines, there was a variety of treatment options that could be used to clinically manage this patient with chronic neck pain. As previously stated, classification systems can minimize clinical variability and encourage standardized rehabilitation with respect to specific subgroups for neck pain. Thus leading the selection of optimal interventions that address the needs of the patient. The literature suggests that patients with chronic neck pain have decreased neck strength compared to healthy people.[4] Hence, applying the classification system, as well as considering the patient's presentation, it seemed appropriate for the patient to be assigned to the conditioning classification. Based on this classification, a treatment approach was adopted and implemented that matched the proposed needs of this patient.

CASE DESCRIPTION

History

The patient was a 35-year-old male with chief complaint of neck pain with gradual onset of slow cramping, tight neck muscles, and difficulty breathing over the last year. The patient reported the pain and stiffness in his neck that progressively increased over the previous months. He denied any comorbidities, and the patient's past medical history appeared unremarkable, except for a "rotator cuff injury secondary to being in a car accident a couple years ago." He did not have any recent radiographs. Patient reported being on no medications, with

Table 1. Literature Review of Treatments for Patients with Neck Pain

Authors	Exam findings	Outcome
Ylinen et al, 2007	- Nonspecific neck pain - Stretching 5x/wk for 12 wks - Manual therapy 2x/wk for 12 wks	Both stretching and manual therapy decreased neck pain and disability.
Ylinen et al, 2007	- Training program (isometric resistance & endurance training) of neck muscles - Period of 1 yr	Training program done for 1 yr has long-term effects up to 3 years even with poor compliance.
Thomas et al, 2004	- Activation of deep neck flexors & dynamic strengthening of neck mm - Period of 6 wks - Period of 6 months	Significant decrease in pain and increase in disability and isometric neck strength after 6 wks but not as effective after 6 months.
Sarig-Bahat 2003	- Chronic or frequent neck disorders - Proprioceptive exercise and dynamic resisted strengthening - Performed on neck and shoulder mm	Proprioceptive exercise and dynamic resistive strengthening reduced pain and disability.
Sarig-Bahat, 2003	- Chronic or frequent - Group exercise - Neck schools - Extension-retraction (single sessions)	Group exercise, neck schools, or extension-retraction exercises were not effective in reducing pain or disability.
Graham et al, 2006	Mechanical neck disorders 1. intermittent traction 2. continuous/static traction	1. Reduced pain 2. No pain reduction
Jull et al, 2007	- Chronic neck pain with altered proprioception - Proprioceptive training & craniocervical flexion training	Proprioceptive training and craniocervical flexion training both alleviated pain and benefited impaired cervical joint position sense
Viljanen et al, 2003	- Chronic nonspecific neck pain - Dynamic muscle training of neck & shoulder mm (using dumbbells) for 12 wks - Relaxation training for 12 wks - Ordinary activity for 12 wks	Dynamic muscle training or relaxation training was not effective in reducing neck pain compared to ordinary activity after 12 wks.

the exception of ibuprofen for his symptoms. The patient admitted to having a history of headaches with a frequency of two headaches per day. Past medical treatment included chiropractic treatment about once a month with minimal long-term relief. Activity limitations included decreased ability with occupational tasks, such as "designing paintings" and daily general tasks. The physical demands of this job included prolonged sitting and standing postures with upper extremity use, and intermittent overhead reaching and lifting. It appeared that his worsening condition was also having a profound effect on his personal life as well. He reported a decreased ability to play with his daughter, specifically his ability to lift her up without pain. Since the patient's pain was increasing, the patient stated he was afraid to participate in recreational activities, (ie, martial arts and recreational football). These activity limitations were considered in the development of patient centered goals once a diagnosis was obtained in this patient. We proceeded in the patient-client management model by administering tests and measures appropriate for this patient.

Examination

Tests and Measures (Medical Screening and Systems Review)

Medical screening regarding this patient was deemed unremarkable, and did not reveal any red flags preventing further testing and physical therapy intervention. An examination of both the patient's neck and shoulder was performed. Initially, outcome measures included the Patient Satisfaction Functioning Scale (PSFS) equal to 5 and a Neck Disability Index (NDI) of 20/50.

The patient reported neck pain currently at 4-5/10; at best 3/10; at worst 8-9/10. Patient reported pain as constant and described it as a deep, crampy, achy feeling on the right side along the medial border of his scapula and along the spine that increases with head movement. The patient reported only one incident of tingling in the right hand radiating to the tips in all 5 digits "only when his neck muscles tighten up" but he did not have any radicular symptoms at the time of examination. The patient reported that his neck pain was worse in the evening and that he was awakened by pain and sometimes had trouble falling asleep because of the pain. Table 2 depicts aggravating and relieving factors for his pain.

Cardiovascular and integumentary systems were unremarkable. In terms of the neuromuscular system, the findings included the following: sensation of light touch was grossly intact in bilateral upper and lower extremities. Upper quarter screen revealed no positive dermatomal or myotomal findings and intact reflexes for C5-C7.

Tests and Measures (Musculoskeletal System)

Posture revealed slight forward head, rounded shoulders, flat cervical lordosis, winging of the scapulae bilaterally, increased paraspinal tone bilaterally, and

Table 2. Aggravating and Relieving Factors of this Case Report

Aggravating Factors:	Relieving factors:
1. Prolonged positioning during occupational tasks 2. Turning/twisting of head and neck during daily activities 3. Lifting 50# or more during occupational and personal tasks 4. Lying on right side with right arm tucked under 5. Cold temperatures (ie, cold pack)	1. Warm temperatures (ie, heating pad) 2. Light massage only (note: pt reported he passed out for approx. 10 sec 2x after massages were performed)

Table 3. Active Range of Motion Results

AROM: Cervical spine:		
	Degrees	Pain
Cervical flexion	40°	Yes (increased)
Cervical extension	40°	Yes (increased)
Left side bending	40°	No
Right side bending	40°	No
Left rotation	70°	Yes (increased)
Right rotation	70°	Yes (increased)

Table 4. Long-term Goals Developed for this Patient

LTG: (6 weeks)
1. Decrease Patient Satisfaction Functioning Scale ≥ 2 pts.
2. Increase Neck Disability Index ≥ 40/50.
3. Decrease neck pain to 1-2/10 at worst with activity in order to perform activities of daily living.
4. Patient able to work on computer ≥ 60 minutes with decreased pain and increased postural awareness.
5. Patient to demonstrate increased postural awareness 90% of the time in order to work with decreased pain.
6. Patient able to read ≥ 45 minutes without pain secondary to increased postural awareness and decreased muscular tightness.
7. Patient able to lift ≥ 50 # with decreased pain secondary to increased muscular strength in scapular region and increased postural awareness in order to lift children.
8. Patient to be independent with Home Exercise Program.

humeral head displaced approximately 2/3 forward. Strength testing was performed with group manual muscle testing and no deficits were found. Range of motion was performed consistent with standardized procedures and quantified using an inclinometer. Table 3 reveals active range of motion (AROM) findings for the upper quarter as it pertains to this specific case. It should be noted that these measurements were performed in the seated standardized position. Interestingly, no cervical ROM limitations were noted with the patient in the supine position during passive range of motion (PROM) assessment. Active ROM for the upper extremity was within normal limits bilaterally.

In terms of palpation assessment, the patient was extremely hypersensitive to light touch throughout the cervical spine as well as along the medial border of the right scapula along the spine. Additional special testing for the cervical spine yielded no positive findings and no reproduction of radicular symptoms. Fundamental movement testing was performed for the upper quarter and revealed poor neuromuscular control of the scapula along with hypermobility of the shoulder blades bilaterally (left greater than right), during shoulder elevation movement.

EVALUATION

Clinical Decision Making

Based on the clinical presentation, clinically meaningful impairments were considered and used to develop an operating hypothesis potentially explaining the pathomechanics pertinent to this patient. The results of the examination were discussed with the patient who subsequently agreed with the findings. The patient's chronic cervicothoracic pain was hypothesized to be a result of improper biomechanics and poor neuromuscular control of the scapula and upper quarter. Based on the discrepancy between active ROM limitations found in the seated position, and the passive ROM findings performed in the supine position, the authors hypothesized that the patient's movement dysfunction could have been a result of increased tone in the surrounding musculature and masking an underlying stability and motor control issue. The increased sensitivity to palpation throughout the neck musculature and along the medial border of the scapula could have been due to excessive guarding of the muscles of the upper quarter, which could have led to decreased neuromuscular stabilization. It should be noted that a deep cervical flexor endurance test was not performed, and therefore could not contribute to our clinical reasoning. These findings appeared to indicate that assignment to the conditioning classification was most appropriate for this patient.

DIAGNOSIS/PROGNOSIS

The patient's diagnosis was determined based on the current evidence and clinical practice guidelines, which placed the patient in the conditioning classification. Prognosis was difficult to apply to this patient due to the chronicity of the symptoms and lack of clinical experience on the part of the therapist; however, the following goals were generated to guide the patient's progress. Table 4 represents the long-term goals developed for this patient.

INTERVENTION

The following plan of care (POC) was designed to address the needs and goals of this patient, as well as our operating hypothesis. The focus was to strengthen the dynamic stabilizers of the scapula, as well as relax the cervical musculature to enhance proper scapulohumeral rhythm. By addressing this muscle imbalance, we were able to facilitate proper activation of the deep neck flexors and scapular stabilizers thus reducing pain and improving overall neuromuscular control of the upper quarter. The patient was seen 3x/wk for 6 weeks for postural awareness; ROM/mobility (cervical, scapular, thoracic); strength (scapular, thoracic); and relaxation techniques. Table 5 describes the specific interventions used in the patient's POC.

Table 5. Plan of Care Description

Intervention:						
	Day 1	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**
Upper body ergometer (backwards)	5 min Level 1	5 min Level 1	5 min Level 1	5 min Level 2	5 min Level 2	5 min Level 2
Pectoralis stretch on foam	2 min	2 min	2 min	2 min	2 min	HOLD 2* pain
Shoulder rolls	10x	2x10	2x15	30x	30x	HOLD 2* pain
Scapular retractions	10x 5 sec hold	15x 5 sec hold	2x15, 5 sec hold	2x15, 5 sec hold	2x15, 5 sec hold	HOLD 2* pain
Scapular retractions with external rotation	15x	2x15	2x15	2x15	2x15	HOLD 2* pain
Cervical spine retractions	5x	5x	5x	5x	5x	HOLD 2* pain
Prone middle & lower trapezius Strengthening	10x 3 sec hold	10x	15x	15x	15x	HOLD 2* pain
Thera-Band rows and shoulder extensions on ball		15x (B) Green T-band	15x (B) Green T-band	2x15 (B) Green T-band	2x15 (B) Green T-band	HOLD 2* pain
Scapular depression on ball		5x 5 sec hold	HOLD 2* pain	HOLD 2* pain	HOLD 2* pain	HOLD 2* pain
Supine ceiling punches					10x	HOLD 2* pain
Mobilizations to the thoracicspine (T3-T5, T8-T9)			10 min	10 min	10 min	8 min
Moist heat c-spine & t-spine	15 min	15 min	15 min	15 min	15 min	15 min
Diaphragmatic breathing (seated & supine while on heat)						8 min

As noted above, the sessions consisted of warming up on the upper body ergometer with proper posture to increase circulation of the upper quarter and increase postural awareness. A pectoralis stretch and shoulder rolls were used to stretch and relax the muscles contributing to the forward shoulders and kyphotic posture while simultaneously focusing on promoting better posture. Scapular retractions and scapular retractions with external rotation were implemented in order to strengthen the dynamic scapular stabilizers so as to optimize muscle imbalance and motor control. Based on the patient's difficulty to relax during the manual interventions, diaphragmatic breathing was implemented in conjunction with the exercises, in order to facilitate decreased tone in the upper trapezius and levator scapulae musculature allowing the patient to be systematically progressed as tolerated through a manual and exercise treatment model.

OUTCOMES

Throughout his POC, the patient's progress was slow, but steady in terms of goal achievement. One consistent observation throughout his sessions was his inability to relax, which reaffirmed the psychosocial behaviors exhibited at initial examination. The patient only completed 6 treatment sessions and was discharged due to 3 consecutive "no show" appointments after the last date of treatment (which was visit 6). Therefore, no updated outcome measures were obtainable that could have been compared to the initial examination. To this end, we caution against using this case report to identify effective or superior interventions as a consequence of fitting into the condition-ing classification. However, the clinician can use this case report as an example of how evidence-based practice can be employed by a novice clinician when arriving at a diagnosis within the patient-client management model.

DISCUSSION

Neck pain has become a significant challenge in today's society and is a common musculoskeletal complaint that physical therapists face in the outpatient clinical setting. The fact that neck pain is a multifactorial disease with its numerous contributing factors has become a challenge in how clinicians medically manage the condition because it leads to clinical variability among physical therapists.[2,5,6] Clinical practice guidelines have been established to provide the best current evidence in dealing with

examination, diagnosis, and intervention to help better understand and manage neck pain.[2]

To help manage this complex condition, a classification system was developed to enhance clinical reasoning and help minimize variability among clinicians when treating neck pain.[9,11] The subgroup applied to the patient in this case was the exercise and conditioning classification in which strengthening of the deep neck flexors and shoulder musculature have been identified to be the most effective interventions.[11] Despite the complaints of headaches, the potential contributing factor was theorized to be the increased musculature tone observed during active movements of the neck. In addition, the patient's fear-avoidance behaviors and the chronicity of symptoms suggested a conditioning classification was the most appropriate. It was proposed that by strengthening the deep neck flexors, this patient would develop increased strength of the cervical muscles that directly stabilize the spine and optimize motor control of the upper quarter during functional movements. By optimizing the patient's neuromuscular stabilization strategy during occupational and recreational activities, we could directly impact the patient's activity limitations and patient centered goals.

This case study demonstrates how current literature was applied to a patient with chronic neck pain and assisted the clinical reasoning process for a doctoral physical therapy student in arriving at a diagnosis. Future studies should continue to develop and refine clinical paradigms that can enhance the musculoskeletal management of neck pain that can assist the novice clinician.

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Reverse Total Shoulder Arthroplasty versus Shoulder Hemiarthroplasty in Patients with Rotator Cuff Arthropathy: A Literature Review

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ABSTRACT

Background and Purpose: The purpose of this literature review was to analyze the differences in outcomes of pain, range of motion, and patient satisfaction in persons who have undergone a reverse total shoulder arthroplasty (rTSA) compared to those who have undergone hemiarthroplasty (HA) for rotator cuff arthropathy. **Methods:** A literature search of CINAHL Plus and MEDLINE was completed to identify potential studies (published through October 2011). **Findings:** Seven articles met the inclusion criteria. Reverse TSA yielded greater pain reduction and greater range of motion in shoulder flexion than HA. Patient satisfaction, although significant for rTSA, could not be compared to HA due to dissimilar instruments completed in the studies. **Clinical Relevance:** Physical therapists must be familiar with this procedure and the expected outcomes as increasing numbers of patients undergo rTSA surgery.

Key Words: functional outcomes, rotator cuff tear, shoulder replacement, surgery

INTRODUCTION

A reverse total shoulder arthroplasty (rTSA) consists of switching the normal anatomy of the glenohumeral joint using a prosthesis. Typically a shoulder replacement device mimics the normal glenohumeral anatomy in that a plastic "cup" is fitted into the glenoid fossa and a metal "ball" is attached to the proximal humerus. However, in a rTSA the "cup" and "ball" are switched (Figures 1-4). Mechanically speaking, the center of rotation is moved laterally compared to the anatomically correct glenohumeral joint.[1] The resulting increased tension on the deltoid creates a greater moment arm, and therefore, greater range of motion compared to a shoulder with a nonfunctioning rotator cuff.[1]

Patients who typically undergo rTSA have either a minimally functioning or an absent rotator cuff, with the latter being the more common.[1] Since its approval in 2003, the use of rTSA has grown in popularity for treating rotator cuff arthropathy (RCA) because of its ability to decrease pain while improving function.[2] Rotator cuff arthropathy is the term used to describe the relationship of rotator cuff deficiency leading to glenohumeral joint changes, and potential humeral head collapse.[3]

Prior to the adaptation of rTSA, two main surgical options for RCA existed--hemiarthroplasty (HA) and conventional total shoulder arthroplasty (TSA).[1,2] Both surgeries have demonstrated inconsistent results in regards to relieving pain, restoring functional movement, and increasing postoperative shoulder stability.[1,2] While conventional TSA is used primarily in patients with glenohumeral arthritis and a repairable rotator cuff, it has also experienced a relatively high rate of glenoid loosening.[4] Shoulder HA however is used more commonly for glenohumeral arthritis with a nonrepairable RCA.[1]

The purpose of this literature review was to analyze the differences in outcomes of pain, range of motion, and patient satisfaction in patients who have undergone rTSA compared to those who have undergone HA for RCA.

METHODS

Search

A literature search of CINAHL Plus and MEDLINE was completed to identify studies (published through October 2011) that reported outcomes of HA, TSA, and/or rTSA. The search terms used included: "hemiarthroplasty," "total shoulder arthroplasty," "reverse total shoulder arthroplasty," and "outcomes." The following limits were set: peer-reviewed, research article (CINAHL Plus); English (MEDLINE and CINAHL); and humans (MEDLINE).

Inclusion Criteria

Peer reviewed articles available in English were selected for this review. Articles were included if they had either pain, range of motion, or patient satisfaction outcome measures for rTSA. One reviewer assessed the articles of the studies identified according to the inclusion criteria. The second reviewer independently confirmed the selection.

Exclusion Criteria

The exclusion criterion for this review was if the article did not quantify outcomes using either pain, range of motion, or patient satisfaction outcome measure or if they were a review of the literature.

FINDINGS

The search of CINAHL Plus and MEDLINE identified 51 articles. Of these articles, 7 were retrieved for further evaluation. After detailed review, 7 articles fulfilled the inclusion criteria and were included in this review (Figure 5). Per the articles, rTSA was found to yield greater pain reduction and greater shoulder flexion range of motion than HA. Patient satisfaction, although significant for rTSA, could not be compared to HA due to the use of dissimilar instruments (Table 1).

Hemiarthroplasty

Regarding shoulder HA, Sanchez-Sotelo et al[5] found that glenohumeral arthritis was associated with severe rotator cuff deficiency, or RCA. Furthermore, they found that pain decreased from 4.2 on the visual analog scale, to 2.2 postoperatively. Active range of motion also showed increases with the aver-

Figure 1. Anterior posterior view status post rTSA.

Figure 2. True anterior posterior view (Grashey view) taken in the scapular plane; note 3.0 cm peripheral locking screws used for baseplate stabilization.

Figure 3. Outlet view status post rTSA; note the congruency of glenoid and humeral components.

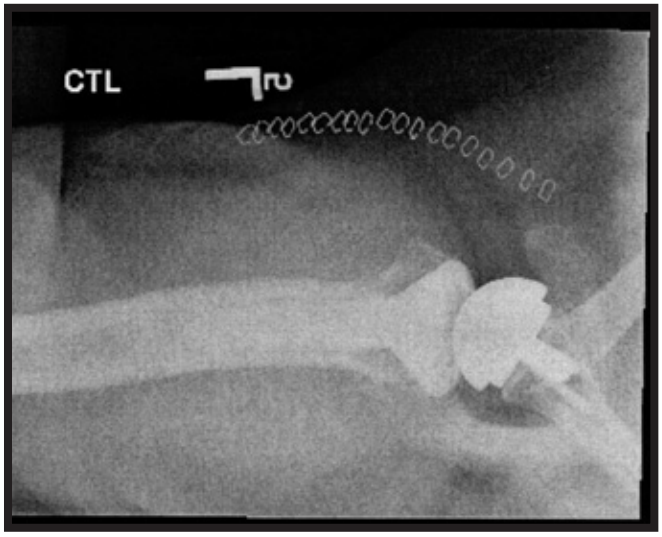

Figure 4. Axillary view status post rTSA.

age patient reaching 91° postoperatively in forward elevation, internal rotation to the first lumbar spinous process, and 41° in external rotation.

In a systematic review by Bryant et al[4] comparing shoulder HA to TSA, patients' status post shoulder HA had an average of 87.9° of forward elevation and 20.4° of external rotation. Twenty percent of the patients who received a shoulder HA eventually required a TSA due to excessive pain and/or stiffness within a 4-year period. Moreover, the remaining patients that underwent shoulder HA who experienced minimal pain at two years were unable to perform work above shoulder level.

Singh et al[6] completed a systematic review that also compared TSA to HA. They found that those who had undergone HA had significantly lower American Shoulder and Elbow Surgeons (ASES) scores, although individual scores were not reported, and also higher revision rates. They did report, however, that adverse events such as intraoperative fracture and infection as well as the Short-Form 36 (both physical and mental components) were similar in both surgeries.

Reverse Total Shoulder Arthroplasty

To date, studies performed on rTSA have included patients with a multitude of preoperative diagnoses. In this regard, Wall et al[3] found that active elevation increased from an average of 86° preoperatively, to 137° postoperatively and internal rotation improved from the fifth to the fourth lumbar vertebrae for patients with varied diagnoses postoperatively after rTSA. At the conclusion of this study, 93% of patients were either very satisfied or satisfied with their procedure. This was reflected in the improvement in every component of the Constant-Murley score (including pain levels).[3]

Boileau et al,[7] Cuff et al,[8] and Stechel et al[9] compared rTSA outcomes in patients who underwent surgery for rotator cuff arthritis, fracture sequelae, failed rotator cuff surgery, or revision arthroplasty. Although all patients improved in these studies, those with rotator cuff arthritis preoperatively experienced the greatest improvements. Despite different outcome measures (ie, two of the studies used the ASES shoulder score and one used the Constant-Murley score), all 3 showed significant improvement. Cuff et al[8] reported postoperative forward elevation increases to 118°, abduction to 109.5°, and external rotation to 28.2°. Stechel et al[9] demonstrated increases to 105° in forward elevation and 93° of abduction.

Mulieri et al[10] completed a study with patients who had undergone a rTSA for an irreparable rotator cuff tear, yet without glenohumeral arthritis. The study used two groups; patients without previous surgery and patients with a previously failed rotator cuff repair. Both groups showed significant improvement in forward flexion, abduction, and internal rotation. In addition, 85% of the patients reported self-satisfaction of excellent or good along with pain level reduction scores increasing on the ASES score from 17.3 to 42.4 in those without previous surgery, and from 19 to 39.8 in those with the previously failed surgery.[10]

Frankle et al[11] and Nolan et al[2] studied patients undergoing rTSA specifically for RCA. Frankel et al[11] completed research comparing patients who had undergone previous shoulder surgery to those who

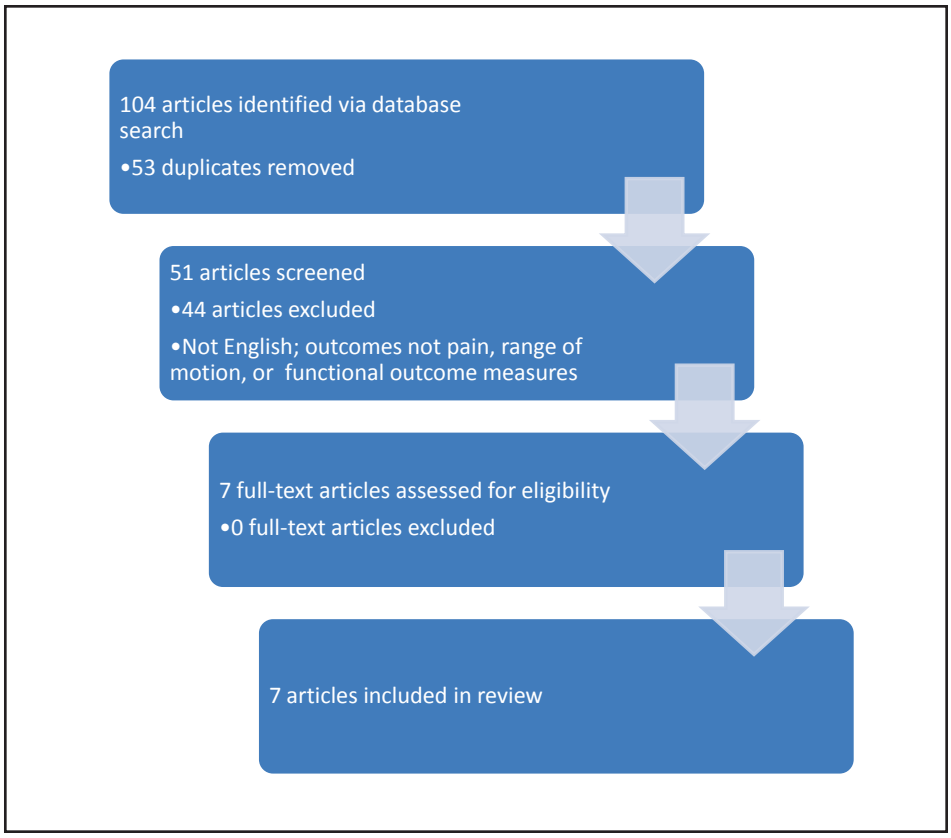

Figure 5. Search strategy flow diagram using CINAHL Plus and MEDLINE databases.

did not. While patients without previous shoulder surgery experienced greater results, all patients improved in external rotation (35.9°), forward flexion (105.1°), and abduction (101.8°). Overall, 95% of patients in this study reported their satisfaction as good, excellent, or satisfied.[11] Nolan et al[2] also reported that this patient population increased significantly in forward flexion (to 121.3°) and experienced decreased pain levels from 7 to 1.4 on the visual analog scale postoperatively.

DISCUSSION

Reverse TSA is a relatively new surgical procedure for patients experiencing a myriad of glenohumeral issues. This list includes, but is not limited to, rotator cuff arthropathy, rheumatoid arthritis, osteoarthritis, humeral fractures, and revision arthroplasties. Before the adaptation of the rTSA, most shoulder dysfunction was fixed with either a TSA or shoulder HA.[6] A study by Bryant et al[4] compared TSA to HA and reported that TSA demonstrated more consistent positive short-term results in patients with shoulder osteoarthritis. However, Singh et al[6] reported shoulder HA was used more for those with shoulder rotator cuff pathology.

Despite the preference of shoulder HA over TSA regarding patients with rotator cuff problems, shoulder HA has demonstrated inconsistent results regarding pain relief and postoperative range of motion.[6,11] Boileau et al[7] also found that the outcomes related to range of motion have been conflicting. As the volume of conflicting data grew, so did the popularity and intrigue of rTSA.[1]

Thus far rTSA has shown positive results in procedures for various diagnoses. Wall et al[3] reported positive outcomes with a rTSA for patients with revision arthroplasty, massive rotator cuff tear, primary osteoarthritis, posttraumatic arthritis, tumor, acute fracture, and rheumatoid arthritis. Numerous studies have shown positive results using the rTSA specifically in those with RCA.[3,7,8,11] Cuff et al[8] have shown that patients with rotator cuff deficiency displayed significantly greater improvements in forward elevation and abduction as well functional shoulder scores postoperatively compared to patients with a previous failed arthroplasty, or after a failed rotator cuff surgery.

Although the number of diagnoses that can be corrected using the rTSA procedure is extensive and the majority of these patients have experienced positive outcomes, those undergoing a rTSA primarily for RCA have shown the greatest improvements.[7,9] Specifically, functional improvements in range of motion and significant reductions in pain have been documented.[2,11] Coordinated physical therapy care between the surgeon and physical therapist has demonstrated impressive results evidenced by significant reduction of pain and improved functional use of the arm when using a protocol outlined by Boudreau and colleagues.[1] In addition, patient satisfaction levels have also been consistently high after rTSA in multiple patient populations.[7,10,11]

Due to the complexity of the procedure, the complication rate is an area of concern with rTSA.[8] Stechel et al[9] reported scapular notching, heterotopic ossification, dislocations, and acromion fractures as some of the more common complications. Of particular interest is scapular notching, which appears to be the most common adverse event associated with rTSA and is currently being researched.[8] To combat scapular notching, a study was undertaken by Cuff et al[8] comparing rTSA procedures using different length locking screws to hold the baseplate on the glenoid. Compared to a study done by Frankle et al[11] that used a 3.5-mm peripheral screw and a lateralized center of rotation of the prosthesis, Cuff et al[8] reported on the use of a 5.0-mm peripheral locking screw and an inferior tilt of the prosthesis. The longer screw center of rotation lateral to the glenoid and inferior tilt resulted in a decreased rate of scapular notching and overall complication rates in general.[8]

Regarding instability, Nolan et al[2] noted two pathologies of concern that may be contraindications for rTSA; complete deltoid paralysis and a preoperative subscapularis rupture. Even with implantation of the prosthesis, it is recommended that the subscapularis tendon be repaired if possible.[2] To date, there has been a limited number of dislocations cited through multiple studies. Cuff et al[8] and Stechel et al[9] each reported only 3 cases of dislocation out of 58 and 59 shoulders, respectively, (approximately 5%) and Wall et al[3] reported a dislocation rate of 7.5% in their 2007 study. No definitive association between glenoid loosening, eventually leading to instability or dislocation, and scapular notching can be confirmed in the literature at this time.[2]

CONCLUSION

Historically shoulder HA has been the surgery of choice for RCA, but the much newer rTSA has not been compared to HA extensively. Although a paucity of research

Table 1. Composite Data Results from both rTSA and HA

	rTSA	HA
Pain: Visual Analog Scale	7 pre-op to 1.4 post-op[5,7]	4.2 pre-op to 2.2 post-op[5]
ROM:		
Flexion	↑ 105° – 137° [1,2,8,9,11]	↑ 87.9° – 91° [4,5]
Abduction	↑ 93° – 109.5° [8,9,11]	NT
External Rotation	↑ 28.2° – 39° [8,11]	↑ 20.4° – 41° [4,5]
Internal Rotation	↑ L4 spinous process[2]	↑ L1 spinous process[5]
Outcome Measures:		
ASES	17.3 pre-op to 77.6 post-op[7,8,10]	NT
Constant-Murley	18 pre-op to 60 post-op[2,9]	NT

rTSA, reverse total shoulder arthroplasty; HA, hemiarthroplasty; ASES, American Shoulder and Elbow Surgeons; NT, not tested

exists comparing rTSA to shoulder HA, the results of rTSA in the literature have been consistently positive with strong outcomes. Since current evidence reveals pain reduction and functional range of motion can be adequately restored, patients with RCA may elect for a rTSA procedure over shoulder HA with increasing frequency. More research is needed related to long term follow-up and investigation of new designs and ideal patient selection. Physical therapists must be familiar with this procedure and the expected outcomes as an increasing number of patients choose rTSA surgery.

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Educational Lifting Techniques for Thoracic Spine Injury Prevention: A Literature Review with Case Study

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ABSTRACT

Background and Purpose: Eighty percent of the working population will report back pain during some point throughout their lifetime. A number of the back injuries reported involve the thoracic region, but little research has addressed this area. The purpose of this literature review was to determine the effectiveness of educational lifting techniques for thoracic spine injury prevention using a case study. **Methods:** A literature search of CINAHL Plus and MEDLINE was completed to identify potential studies published through September 2011. **Findings:** Seven articles met the inclusion criteria: two regarding the reported risk factors, prevalence, and incidence of thoracic spinal pain, 3 addressing spinal loading on the thoracic spine, and two describing the effectiveness of back schools. **Clinical Relevance:** Physical therapists should understand the risk factors, incidence, and prevalence of thoracic spinal injury so, programs and practice protocols may be developed and implemented to prevent and minimize injuries of the thoracic spine.

Key Words: back school, epidemiology, spinal loading, thoracic pain

INTRODUCTION

A review of the literature reports that 80% of the working population within the United States will report back pain during their lifetime.[1] Therefore, it is important to understand risk factors associated with back pain in order to adequately prevent these injuries. In 2009, Occupational Safety and Health Administration (OSHA) reported 36.5% of all reported sprains, strains, and tears were related to the back, making this the most affected and reported body region. When considering all occupations, these injuries result in 7 missed days of work per year on average.[2] As a result, the National Institute for Occupational Safety and Health (NIOSH) reports the health care industry spends approximately $20 billion annually in direct and indirect costs related to back injuries within the United States.[3]

The majority of back pain reports in the current literature focus on the lumbar or cervical region. However, a number of the reported back injuries involve the thoracic region.[4,5] In many studies, the phrase "back pain" is poorly defined which could result in some reported back pain as originating in the thoracic spine. Due to the lack of research on thoracic pain, there is little known regarding risk factors and epidemiology, both of which are important factors to consider when developing a prevention plan for these injuries. Prevention of thoracic spine injuries, as well as back injuries as a whole is an important aspect for researchers to further investigate since musculoskeletal injuries encompass the majority of health care dollars spent within this country.[4,5] In addition to the general financial impact on health care, companies view ergonomics as a way to solve injury problems in a cost effective manner. In other words; ergonomics equals good economics.[6]

In 2009, Briggs et al[4] reported common risk factors associated with thoracic spinal pain specifically within the work place. These include high work load, high work intensity, ergonomic problems in the work place, performing boring and tedious tasks, and high physical stress.[4] Using these risk factors, treatment strategies for general back injury prevention have included exercise, education on proper lifting techniques, shoe inserts, back braces to be worn during lifting activities, ergonomic equipment such as a lift assist, modification of activity, and administrative or social changes. Not all interventions are equally effective. The combination of exercise and education with the focus on exercise have been shown to be most effective in the prevention of back injuries.[7] To date, no study has focused on the prevention of thoracic spinal pain and injury. Therefore, the purpose of this study is to determine the effectiveness of educational lifting techniques for thoracic spine injury prevention using a case study.

CASE DESCRIPTION

Patient Characteristics

A 67-year-old male presented to the outpatient physical therapy clinic with a referral for shoulder pain. Upon initial physical therapy evaluation, the chief complaint was right posterior aching arm pain along with throbbing pain in the forearm and digits 2 through 5. He reported injuring himself at work when lifting a 50 pound box into a truck. The patient worked during the school year as a food distributor to local school districts. At the time of injury (ie, during the lift), he had felt a twinge of pain, but continued on with the rest of his day and only began to feel aggravated symptoms the following morning. The pain became worse when the arm was in a dependent position and when lying down. The referring physician ordered an MRI of the cervical region that concluded there was degeneration of the C4-5 spinal segments. The patient lived with his wife and grandchildren and was an active participant on a competitive men's softball team. His past medical and surgical history were unremarkable.

The following significant findings were found during the physical examination; kyphotic posture, painless shoulder range of motion, decreased right cervical rotation and backward bending with an increase in pain at end range, positive Roos test and shoulder girdle relief sign for thoracic outlet

Table 1. Search Terms Used in MEDLINE and CINAHL Plus Databases

Database Search Terms				
Key Terms	Thoracic spine injury	Lifting	Ergonomics	Compressive forces
Secondary Terms	• Thoracic spine • Injuries to the thoracic spine • Thoracic • Thoracic pain • Spine	• Lifting mechanics • Lifting biomechanics • Occupation	• Back school • Education • Educational lifting mechanics • Injury prevention • Preventative injuries • Prevention • Prevention of injury	• Spinal load • Spinal loading • Thoracic spinal loading
*These search terms were used in the following databases: MEDLINE, CINAHL Plus				

Table 2. Literature Regarding the Reported Risk Factors, Prevalence, and Incidence of Thoracic Spinal Pain

Citation/Topic	Type of study/subjects	Interventions and control groups	Clinical outcome measures/ other findings	Conclusions
Briggs 2009[5] Risk factors, incidence, prevalence of TSP	Systematic review (33 studies) Articles reviewed were case control, cross sectional, or cohort study and was performed on community based population.	None	• Prevalence of TSP • TSP associated with backbag use • TSP interfering with leisure • Risk factors	• Adults reported more pain of 1 year duration • More prevalent in females. • 23.5% of those reporting TSP have difficulty with ADLs lasting 13.5 days on average.
Briggs 2009[4] Prevalence and risk factors of TSP	Literature review (52 studies) Prospective and cross sectional studies were reviewed looking at the adult working population.	None	• Occupation • Ethnicity • Sample size by gender • TSP prevalence • Definition of TSP	• Manual laborers reported highest 1 yr. prevalence at 38%. • Work related risk factors; high work load, high work intensity, perceived ergonomic issues, tedious task performance.
TSP = thoracic spinal pain, which is defined as pain experienced between the first and twelfth thoracic vertebrae; ADLs = activities of daily living				

syndrome, trigger points in the thoracic musculature, and hypomobility of segments T3-5 with an increase in symptoms during spring testing of T4. Allen's test and Adson's test for thoracic outlet syndrome were found to be negative along with all upper limb tension tests. The pain did not present in a dermatomal pattern or a cutaneous nerve distribution. From this clinical presentation, it was determined the patient was presenting with symptoms representative of T4 syndrome.

METHODS

Search Strategy

Throughout the search of the literature, no specific article or study could be found regarding prevention of thoracic spine injuries. Thus, a search of the literature was conducted reviewing abstracts focusing on spinal loading of the thoracic spine during a lifting task relating to an increased risk of sustaining an injury along with articles analyzing the effectiveness of a back-school for preventing thoracic spine injuries. Articles deemed appropriate then underwent an analysis of the full text and a summary of the most appropriate articles was drafted. There was no time frame placed on articles appropriate for use in the review. The following search terms were used to navigate through the existing literature (Table 1).

FINDINGS

Seven articles were located and deemed acceptable from the database search. Two articles regarding the reported risk factors, prevalence, and incidence of thoracic spinal pain were found (Table 2). The notable risk factors of thoracic spinal pain included high work load, high work intensity, perceived ergonomic issues, and tedious task performance.[4]

Three articles were located addressing spinal loading on the thoracic spine (Table 3). Researchers found the highest force on the thoracic spine occurred when a 10 kg load was held in one's hands while their elbows were bent to 90°.[7] This resulted in a load increase of 448% compared to quiet standing.[7] In comparison to the cervical and lumbar spine, the thoracic spine was able to distribute the load with the rib cage and sternum resulting in a decreased average load by 222 N.[7] Additionally those individuals who demonstrated a high kyphosis demonstrated 14% greater compression of

Table 3. Literature Regarding Spinal Loading on the Thoracic Spine

Citation/Topic	Type of study/subjects	Interventions and control groups	Clinical outcome measures/ other findings	Conclusions
Iyer 2010[7] Spinal loading of thoracic and lumbar vertebrae.	Experimental observational design. Population; 14 males of average age 56 years enrolled Framingham Heart Study Multidetector CT study.	All subjects performed; relaxed standing, lateral moment, 30° trunk flexion, 15° trunk extension, 10 kg load with elbows flexed to 90°, 10 kg load with 30° of trunk flexion and arms at side.	• Muscle forces • Vertebral spinal loads T6-L5	• Highest force on thoracic spine was during 10 kg load in hands while elbow was bent to 90°. Increase in 448% of spinal loading compared to quiet standing. • Average compressive force in thoracic spine = 752 N, increasing rib cage/sternum stiffness decreased average load by 222 N. • Compressive forces strongly correlated with in vivo intradiscal pressure in the thoracic spine (r^2=0.95).
Briggs 2007[8] Effect of thoracic kyphosis on spinal loading	Experimental observational design. Population: 44 subjects of geriatric population with and without osteoporosis. Divided into high kyphosis and low kyphosis groups.	Each subject received lateral view radiographs of thoracic and lumbar spine during quiet stance. Digital image also taken during quiet stance with the subjects wearing reflective markers at anatomical landmarks.	• Segmental load parameters found using equation on spinal loading • Mixed model analysis used to compare normalized net force and muscle force between spinal segments.	• Peak mean flexion moment occurred at T8 in both groups. • Normalized compression forces increased as a function of vertebral level. • High kyphosis group demonstrated 14% greater compression compared to low kyphosis group. • Anterior and posterior shear forces of high kyphosis group were greater than low kyphosis group.
Marras 2003[9] Gender differences of spinal loading	Experimental design laboratory study. Population: 40 subjects (20 males, 20 females) who were asymptomatic for low back pain.	Subjects performed asymmetric and symmetric lifts in the sagittal plane while standing on a force plate.	• Compression on the spine. • Lateral shear on the spine. • Anterior-posterior shear on the spine.	• Increased box weight, lower origin height, and greater task asymmetry increased spinal loading. • Compressive loading in males was 12.6% greater than females.

the thoracic spine compared to those with a lower kyphosis.[8]

Finally, the effectiveness of back schools was described in two articles (Table 4). Overall, there was a moderate level evidence found supporting back school instruction as an effective means to preventing back pain.[10] However, the greatest amount of evidence lies in the combination of back school instruction and exercise as a prevention of back pain.[11]

DISCUSSION

Many studies in the literature support the prophylactic use of back school prevention strategies to help avoid low back injuries.[12-14] Low back injuries are commonly treated in physical therapy clinical practice in comparison to thoracic spinal injuries; therefore, the majority of the literature has focused its efforts on dealing with prevention strategies of the low back. Thoracic spinal injuries do still occur and therapists need to be equipped with the proper prevention strategies for these patients.

The patient in this case worked in a school district as a food distributor. His job description consisted of being able to lift a crate weighing up to 70 pounds and load it on and off of a truck frequently throughout his work day without any help. These duties put the patient at risk for sustaining a thoracic spinal injury due to the fact his job included high work load, ergonomic issues, and high work intensity.[4] In addition, the patient is also at risk for an increase in compressive load on the thoracic spine because he is male and was observed to have a kyphotic posture. As stated in the literature, men have 12.6% more compressive load in comparison to females and a kyphotic posture in general increases anterior and posterior shear forces of the spine.[8,9]

Comparing compressive forces through the lumbar spine, it has been found that the thoracic spine does not reach the same maximum compressive forces as the lumbar spine during a lifting task. The thoracic spine is able to share the load with the sternum and ribcage allowing for more distribution of forces. The largest amount of compressive force applied to the thoracic spine is at the point during a lifting task where the trunk is in an upright posture and the elbows are in 90° of flexion holding a load.[7] The patient emulates this scenario multiple times during his work day. Although, the thoracic spine does not take on as high of a load as the lumbar spine, the thoracic spine is still at risk for sustaining an injury during a lifting task.

Educational seminars regarding lifting mechanics have been developed in order to teach strategies to decrease the compression forces through the spine during a lifting task.[10,11] As described earlier, many of these seminars focus in on strategies for the lumbar spine. Educational instruction in proper lifting mechanics can also be given in

Table 4. Literature Regarding the Effectiveness of Back Schools

Citation/Topic	Type of study/subjects	Interventions and control groups	Clinical outcome measures/ other findings	Conclusions
Brox 2008[10] Effectiveness of back schools, brief education, and fear-avoidance belief training with low back pain.	Systematic review (8 RCTs) Population: Subjects in articles had reports of nonspecific back pain. Articles researching back schools were included when given by paramedical, physical therapist, or medical specialist.	None	Quality assessment performed to determine level of evidence and recommendations of use of particular intervention.	• Moderate level evidence for back school instruction • 7 of 8 back school intervention resulted in same pain level, disability, and sick leave compared to control long term. • 1 of 8 back school and exercise superior to control group after 3 years in recurrence, pain, disability, and sick leave. • 2 of 8 significant difference in disability and pain at < 6 months after back school and exercise groups compared to control group.
Bigos 2009[11] Effectiveness of prevention interventions for musculoskeletal back problems in the working adult.	Systematic review (20 RCTs) Population: adults ranging from 18-65 year old with or without reports of prior back problems not currently seeking treatment.	None	• Effect size calculated between intervention and control groups. • Rate ratios comparing control and intervention groups with injury ratios reported.	• 7 of 8 exercise interventions yielded statistically significant decrease in back problems. • 4 of 8 showed exercise plus education was more effective than education alone • No other intervention was significant for reducing back pain. • 4 trials found no effectiveness of back education
RCT = randomized controlled trial				

a variety of ways including during a physical therapy session for an existing back injury, an offering by a physical therapist office that is open to the community, or during a company inservice to educate their employees on proper lifting techniques in an effort to prevent episodes of back pain. However studies looking at the effectiveness of back school instruction have found that back school instruction alone is not an effective way to prevent further back injuries.[10,11] Rather a combination of exercise and education on lifting strategies or exercise alone is more superior in prevention than education alone.[10,11]

The majority of the studies analyzing the effectiveness of back school instruction were specific to the lumbar spine injuries. Thus, it cannot be assumed thoracic spine injuries would be most effectively prevented with the same education or prevention techniques as the loading of the thoracic spine is biomechanically different than in the lumbar spine.[7] Throughout the research reviewed, there is not a sufficient number of studies focusing on the effectiveness of back school for the thoracic spine. However, the research has adequately developed studies regarding measurements of various spinal forces throughout different tasks and at rest in the thoracic spine. Areas for future research could include development of risk factors specific to thoracic spinal pain, incidence statistics, and prevention strategies.

Over the course of treatment, many different interventions were introduced to the patient including thoracic mobilizations and manipulations, trigger point release of thoracic musculature, thoracic range of motion exercises, strengthening exercises, and lifting mechanics education. Although many basic lifting principles such as lifting primarily with legs and keeping an object close to ones center of mass was reviewed, specific methods to correct poor thoracic spine posture during lifting were taught. These included firing the lower trapezius and rhomboid muscles to maintain a retracted scapular position during lifting rather than just concentrating on firing the transverse abdominus musculature as is traditionally instructed to prevent low back injury. Within 4 to 5 treatment sessions consisting of thoracic mobilizations, spinal thrust manipulations, trigger point release, and patient education, the patient reported relief of his symptoms. Although addressing a patient's current impairments is critical, equipping a patient with strategies to avoid sustaining a similar injury is just as important.

CONCLUSION

In today's health care environment, physical therapists must embrace the role of prevention, health, and wellness of all their patients. From a physical therapy perspective being able to put together the job demands or lifestyle choices of individuals in respect to the risk for particular injuries is an important skill to possess. While therapists spend the majority of their day relieving patients of their symptoms, there must be an emphasis to incorporate prevention of further injuries. Physical therapists can play an integral role in health and wellness and as a result decrease the health care dollars spent on injuries and diseases that can be prevented. Therefore it is important for a physical therapist to understand the risk factors, incidence, and prevalence of thoracic spinal injury. As a result, the profession can develop programs and protocols that can be implemented into practice and into a client's routine preventing the development of thoracic spinal injuries. In comparison to lumbar and cervical spine injuries, future studies for prevention of thoracic spine injuries are still important despite the small population size.

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Nintendo Wii Fall Reduction Effectiveness in the Elderly and its Ability to Assess Balance using Center of Pressure: A Literature Review

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ABSTRACT

Background and Purpose: One or more falls are experienced by about 30% of people over 65 years old each year. The purpose of this literature review was to determine if the Nintendo Wii is effective to decrease fall risk in the elderly and to determine if it is comparable to other mechanical devices in assessing balance deficits. **Methods:** A literature search of Cochrane, PubMed, CINAHL, Medline, and Google Scholar was completed to identify potential studies (published through October 2011). **Findings:** Eight studies were located that used the Nintendo Wii: two were single patient case studies, 4 used elderly patients, and 3 used the Timed Up and Go outcome measure. **Clinical Relevance:** Since increased falls and decreased balance correlate to lower levels of physical activity in the elderly population, strategies to address balance deficits should be incorporated into the rehabilitation session of every elderly patient.

Key Words: falls, force plate, Timed Up and Go, vestibular dysfunction

INTRODUCTION

Falls are an important issue facing the elderly population. One or more falls are experienced by about 30% of people over 65 years old each year.[1-4] Falls are the leading cause of injurious death in those greater than 65 years old,[3-6] with 82% of fall deaths occurring in those over age 65.[7] Furthermore, falls are the leading cause of death from injury in this population.[1,8]

Falls also account for 40% of admissions to nursing homes.[9] By the year 2030, about 3 million people age 65 and older will reside in nursing homes across the country.[7] Only 5% of adults age 65 or older currently reside in nursing homes, but falls in this population account for 20% of deaths.[7] This population also experiences twice the amount of falls per year as compared to community dwelling adults, and those who fall once have an increased chance of falling again. The loss of mobility due to falls in this population increases the risk of subsequent falls and related injuries.[3] This can result in an increased cost due to the care required for these injuries and to provide rehabilitation to prevent reoccurrence. By 2020, the cost of injurious falls is expected to be around $54.9 billion, with the cost increasing with the age of the resident.[7]

Researchers have found a direct correlation between increasing age and incidence of falls,[1,2,10,11] making fall prevention a priority by those working in nursing homes. Many factors can be attributed to an elderly adult's increased fall risk. Underlying medical conditions, medication use, impairments, disabilities, and age related deterioration are among those factors.[2] Although some of these factors are not modifiable, it has been shown that changes can be made to decrease the risk by assessment of strength, flexibility, balance, and reaction time. These factors are most easily modifiable.[2,12] Research has shown that decreased balance in particular is a highly predictive risk factor for elderly adults.[4,5] Interventions focusing on increasing balance to decrease the risk of falls should therefore be implemented in nursing home settings. Optimal interventions to improve balance and decrease falls have not been established and the best method is still being investigated.[2,13]

Historically, balance has been objectified using expensive tools such as force plates, Balance Master, and EquiTest.[14] These systems use the center of pressure (COP) as a method to objectify balance performance and to track it as the patient progresses through treatment. Recently, the Nintendo Wii system has been used to objectify balance and to help a patient make improvements in their balance through interactive games. Due to the increased popularity of the Nintendo Wii gaming system in rehabilitation settings, a review of the literature was done to determine the effectiveness of this system to decrease fall risk in the elderly population. The Nintendo Wii was also compared to the more expensive force plates, Balance Master, and EquiTest to determine how its ability to measure a patient's COP compared to these devices. Finally, pros and cons of the Nintendo Wii system are discussed based on the literature to allow clinicians to make an informed decision about whether or not to use the gaming system during their treatments. The purpose of this literature review was two-fold: (1) to determine if the Nintendo Wii is effective to decrease fall risk in the elderly, and (2) to determine if the Nintendo Wii is comparable to other mechanical devices in assessing balance deficits.

METHODS

Search Strategy

The following databases were searched: Cochrane, PubMed, CINAHL, Medline, and Google Scholar using search terms listed in Table 1. Searches took place during September and October 2011 and the following limits were set: English language, published 2000 to present, and randomized controlled trials or case studies. Abstracts were compiled and relevant literature was reviewed.

Findings

Eight studies were reviewed (Table 2). Of those 8 studies, two case studies looked at a single patient and their responses to the interventions. Four studies included patients 65 years or older, 3 studies used the Timed Up and Go (TUG) as an outcome measure, and all of the studies used the Nintendo Wii as an intervention. In 2000, Shumway-Cook

Table 1. Database Search Strategies

Key Terms	Falls	Nintendo Wii	Balance	Force plates	Balance Master
Secondary Terms	Fall risk	Nintendo Wii Fit	Nintendo Wii Fit	Center of Pressure	Center of Pressure
Tertiary Terms	Older adults	Nintendo Wii Fit Balance Board	Elderly adults		
Supporting Terms	Elderly adults	Falls, elderly adults			

et al[15] investigated the sensitivity and specificity of the TUG in determining fall risk in older adults who were community dwellers. They determined that a TUG score of ≥ 13.5 seconds had a sensitivity of 80% and a specificity of 100%. The TUG was found to correctly predict those who fall 90% of the time. Overall, the researchers concluded that the TUG is a valid tool for determining level of functional mobility and risk of falls in community dwelling older adults.

Of the studies that used the TUG as an outcome measure, two found improvements after using the Nintendo Wii intervention. Clark and Kraemer[9] found an improvement in the TUG from 14.9 seconds to 10.5 seconds. The patient in the study also increased her Berg Balance Score (BBS) from 48 to 53, her Dynamic Gait Index (DGI) score from 19 to 21, and her Activities Specific Confidence (ABC) Scales score from 88% to 90%. The BBS and DGI scores increased to above the fall risk cut-off and her TUG decreased to below the fall risk cut-off. The improvements demonstrated that the Nintendo Wii as an intervention has the potential to improve balance dysfunctions and reduce fall risks in the elderly population. Pigford and Andrews[17] also found an improvement in the TUG from 62 seconds to 47 seconds. They reported 15 seconds as the minimal detectable change (MDC) for the TUG.[17] The patient in the Pigford and Andrews[17] study also showed an improvement in his BBS from 13 to 25, his ABC score improved from 32% to 38%, and his gait speed increased from 0.24m/s-0.39m/s. His performance on the BBS and the TUG exhibited a MDC. Although the patients scores at discharge still put him in the fall risk categories for each outcome measure, it was reported that he had not sustained any falls 6 weeks after he was discharged from physical therapy.

Brumels et al[16] found that there were significant improvements in the average deviation from the COP (p=0.043) as well as improvements in reducing postural sway in subjects using the Nintendo Wii Fit as an intervention. The program using the Nintendo Wii Fit was perceived to be easier and more enjoyable than a traditional balance program as documented by questionnaires. Clark et al[18] showed the Nintendo Wii Balance Board has excellent COP excursion test-retest reliability, relatively equal to that of the force plates. It was also found that MDC value was higher for the Nintendo Wii Balance Board when compared to the use of force platforms in 3 of the 4 trials.

Nitz et al[19] found that the TUG cognitive (ie, TUG performed along with a cognitive task, such as counting backwards) improved from 5.39 to 4.94 seconds, unilateral stance with eyes open improved on the right from 0.78° to 0.67°/second and on the left from 0.79° to 0.65°/second, and body weight decreased from 64.4 to 62.8 kg. The test results also found that lower extremity strength increased. Overall these balance and strength improvements are crucial to decreasing fall risk and increasing functional mobility. Clark et al[20] found that weight-bearing asymmetry and COP path velocity (left and right) both with and without feedback exceeded the threshold for excellent reliability.

Bainbridge et al[21] found that 4 of the 6 participants improved their BBS, with one participant improving greater than the MDC of 5 points. Three participants improved their ABC score, but none improved greater than the MDC of 18%. Three participants improved in forward bending during the multidirectional reach test, but none improved greater than the MDC of 9 cm. Two participants improved in backward bending, but zero improved greater than the MDC of 7 cm. One participant improved in right sidebending and one improved in left sidebending. Three participants improved their COP excursion.

Williams et al[22] found the mean BBS to improve from 39.41 to 48.55. This is greater than the MDC of 5 points, indicating a clinically significant reduction in fall risk. Prior to the start of the study, 10 of the 22 participants had a BBS that indicated a need for interventions focused on improving balance. Following the Nintendo Wii intervention, one participant's score indicated a need for balance focused interventions.

DISCUSSION

In patients over the age of 65, dysfunctions in balance are a major contributor to falls.[9] Using interventions aimed at improving balance to decrease fall risk in the elderly population can reduce the number of people who fall at least once as well as decrease the monthly rate of falling in this population.[23] Physical therapists can play a vital role in helping to decrease the fall rate in the elderly by choosing evidence-based interventions to address these issues. The Nintendo Wii Fit is an innovative virtual reality system that can be incorporated into a rehabilitation program to address balance deficits that may be contributing to an increased fall risk. When used as a therapeutic intervention, the Nintendo Wii Fit system can improve balance, strength, and flexibility, and decreases risks of falls in the elderly population.[9,17,19,21]

Balance can be assessed under static and dynamic conditions and infers postural stability.[14] Early research has employed technologies such as force platforms, the Balance Master, and the EquiTest to determine COP displacements and sway of center of mass (COM). In comparison to the Nintendo Wii Fit system, which currently costs approximately $265 ($175 for the Nintendo Wii system and $90 for the Balance Board), a force plate costs about $6500, the Balance Master $50,000, and the EquiTest $100,000. Kennedy et al[24] reported that the Nintendo Wii Balance Board can directly measure COP with similar accuracy to the use of force platforms. The Nintendo Wii Balance Board was found to have excellent test-retest reliability for COP path length assessment. The gaming system was also found to have concurrent validity with the more expensive force platforms.[18] Chaudhry et al[14] determined that force platforms only measure balance with eyes open and eyes closed with the platform stable. It also

Table 2. Review of Literature

Study	Participants	Intervention	Outcome Measures
Brumels et al, 2008[16]	n=25 (male=12, female=13), age 18-24	4 groups: control (n=7), Traditional balance program (n=5), DDR (n=7), Wii Fit (n=6). Exercise: 12-15 mins, 3x per week, 4 weeks.	SEBT, Single leg force plate balancing data (obtained from an AMTI AccuSway Balance Platform)
Clark et al, 2009[9]	n=1 (female), age 89 y/o	Nintendo Wii Exercise: 60 mins, 3x per week, 2 weeks.	BBS, DGI, TUG, ABC
Pigford et al, 2010[17]	n=1 (male), age 87 y/o	Nintendo Wii Fit Exercise: 60 mins, 5x per week, 2 weeks.	BBS, TUG, ABC Scale, gait speed.
Clark et al, 2010[18]	n=30 (male=10, female=20), ages 23.7 ± 5.6 years	4 standing balance tasks on a FP and on a WBB, single limb stance with eyes open and eyes closed, double limb stance with feet together and eyes closed, and double limb stance with feet comfortable and eyes open.	Total COP length.
Nitz et al, 2010[19]	n=10 (females), mean age 46.6 years	Nintendo Wii Fit Exercise: 30 mins, 2x per week, 10 weeks	6 minute walk test, TUG, TUGcog, the step test, aspects from the mCTSIB, LOS using BBM, flexibility, strength, vibration sense, knee-joint repositioning, tactile acuity, well-being.
Clark et al, 2011[20]	n=23 (males), age 22.3 +/- 4.7 years	Dual Nintendo WBBs	Mean WBA as a percentage of body mass. Reliability was assessed using ICC analysis with an ICC of 0.75-1.0 being excellent.
Bainbridge et al, 2011[21]	n=8 (males=1, females=7), ages 75 +/- 9.7 years	Nintendo Wii Fit Balance Board Exercise: 30 mins, 2x per week, 6 weeks	BBS, ABC Scale, MDRT
Williams et al, 2011[22]	n=22 (males=4, females =18), ages 74-94 (mean age=83.86)	Nintendo Wii Fit Exercise: 20 mins, 3x per week, 4 weeks	BBS

***Abbreviations:** DDR=Dance Dance Revolution; SEBT=Star Excursion Balance Tests; COP=Center of Pressure; BBS=Berg Balance Score; DGI=Dynamic Gait Index;…… TUGcog=Timed Up and Go cognitive; mCTSIB=modified Clinical Test for Sensory Integration of Balance; LOS=Limits of Stability; BBM = Basic Balance Master;……

	Outcomes	Clinical Significance	Limitations
	Traditional balance: statistical significant improvement in SEBT in anteromedial (p=0.004) and medial (p=0.027) directions, and in average displacement from the force plate platform center on the y-axis (p=0.028). DDR: Significant improvement in average displacement of the COP (p=0.031), and in average displacement from center of the force plate platform (p=0.029). Wii Fit: Significant improvement in average deviation from COP (p=0.043).	Both the DDR group and the Wii Fit group had decreased anterior and posterior sway as well as reduced average deviations of COP. Only participants in video game based programs showed improvements in postural sway in the sagittal direction.	Study participants were 18-24 years old. Results may not be able to be applied to the geriatric population.
	BBS increased from 48-53 (improvement of 5 points), DGI increased from 19-21 (improvement of 2 points), TUG increased from 14.9 secs-10.5 secs (improvement of 4.4 secs), ABC score increased from 88%-90%.	The patient in this case reduced her risk of falls, increased her confidence, and improved her ability to ambulate.	Although the results are promising, this study included a single patient and a single therapist.
	BBS increased from 13-25 (improvement of 12 points), TUG increased from 62 secs-47 secs (improvement of 15 secs), ABC Scale increased from 32%-38%, gait speed increased from 0.24 m/s-0.39 m/s.	The patient improved his balance by participating in a rehabilitation program that involved the Wii Fit. He also had a cessation of falls in the subsequent weeks.	This study only included one patient. Researchers did not objectively measure motivation therefore they have no way of knowing if this played a role into the outcomes. Also, the patient was allowed to determine the number of sets performed for each Wii Fit activity.
	Both devices showed excellent COP path length test-retest reliability. Only double limb stance with eyes open and feet apart of the WBB did not reach an ICC value of 0.75, which was the cutoff for excellence (ICC=0.66). Concurrent validity was consistently excellent across all balance tasks and training sessions (ICC=0.77-0.89). The standard error of measurement (FP range=5.3-13.2%, WBB range=8.7-13.1%) and minimum detectable change (FP range=14.5-34.7%, WBB range=24.5-29.4%) values were high. The WBB minimum detectable change value was higher than the FP values in three of the four trials.	The WBB was shown to provide comparable data to the more expensive and cumbersome FP's in regards to COP path length.	The WBB is unable to replace the FP in activities requiring rapid, high force movements. The WBB cannot assess force in the horizontal axis.
	TUGcog increased (p=0.09), unilateral stance bilaterally increased (p<0.05), strength of lower limbs increased (p<0.02), body weight decreased (p=0.09). Fitness, functional mobility, and sensory measures showed improvements trending towards statistical significance (p<0.1).	Balance and strength were significantly improved following participation in a Wii Fit intervention program.	This study included a low number of participants. Participants were asked to keep a log of their sessions and the activities performed which may indicate a lack of standardization.
	WBA with no feedback had an ICC of 0.91 and with feedback had an ICC of 0.81. COP path velocity-left with no feedback had an ICC of 0.75 and with feedback had an ICC of 0.84. COP path velocity-right with no feedback had an ICC of 0.80 and with feedback had an ICC of 0.88.	Using Nintendo Wii Balance Boards to obtain WBA and COP velocity data is reliable (with and without real-time visual feedback). This suggests that the Wii Balance Boards may be used to assess and improve WBA in this population.	Measurements were taken on healthy participants. A carryover to clinical practice in patients with deficits was not researched.
	Four participants had non-statistically significant increases in their BBS's (p=0.066). Three participants had non-statistically significant increases in their ABC Scale score (p=0.753). Three participants had non-statistically significant improvement in the forward bending portion of the MDRT (p=0.588), two in the backward bending portion of the MDRT (p=0.500), one in the right sidebending portion of the MDRT (p=0.465) and one in the left sidebending portion of the MDRT (p=0.465). Three participants had non-statistically significant improvements in the COP excursions (p=0.075).	Results suggest that the Wii Fit Balance Board may be a good option for an intervention with older adults experiencing balance issues.	The study included a small sample size, only one male participant, and no control group. Also, physical activity outside of the study was not controlled for, so results may not only be contributed to the intervention.
	No participants had a decline in balance and the intervention appeared to have had a significant impact on improving balance as per the paired t-test results. Post test BBS scores (mean=48.55, SD=4.58) were significantly greater (t(21)=-9.861, p<.01) than pre test BBS scores (mean=39.41, SD=6.28).	Results suggest that a balance intervention incorporating the Nintendo Wii is effective in increasing the balance of this population.	Participants included community dwelling adults and may not be able to be applied to adults with co-morbidities who may be nursing home dwelling. Also, there was a high number of females in this study and there was no control group.

.....TUG=Timed Up and Go; ABC=Activities Specific Confidence Scales; FP=Force Plate; WBB=Wii Balance Board; ICC=Intraclass Correlation Coefficients;
.....WBA=Weight Bearing Asymmetry; MDRT=Multidirectional Reach Test

measures COP displacements under static conditions. The Balance Master and the EquiTest more realistically measure balance through various test conditions that mimic daily tasks such as slopes, conflicting visual stimuli, abrupt changes in surfaces, and loud noises. The determination of what measurements are important is still left up to the treating physical therapist and more than likely is decided on a case by case basis with the above factors in mind.

When choosing interventions to help improve the balance and decrease fall risk in an elderly patient, the therapist must weigh the pros and cons of using a device such as the Nintendo Wii system. Pigford and Andrews[17] reported that in order to perform the activities using the Nintendo Wii Fit, the patient was required to perform goal-directed shifts in their COP. These shifts were performed with more displacement and velocity when compared to other forms of balance interventions, since the Nintendo Wii provides visual feedback of performance while more traditional balance interventions do not. Pigford and Andrews[17] also reported that the interactive programs that the Nintendo Wii provides should be critically considered when deciding whether or not to incorporate it as an intervention. The games are challenging to most patients, and can be adjusted based on skill level. They are goal-based, and the system provides an objective score at the end that may help motivate the patient to increase their performance in the next round. The Nintendo Wii system is significantly cheaper than other balance systems that provide biofeedback, it is small and portable, and requires minimal setup (plug the system into a television set). Finally the system is very versatile and offers a variety of games to choose from and various heights and surface densities can be used to alter the surface of the Nintendo Wii Fit balance board thereby increasing the difficulty. Unfortunately the Nintendo Wii Fit has limited ability to compute values other than the COP. More expensive measurement systems have the ability to determine values such as excursion, equilibrium scores, postural stability index, and angular momentum. Furthermore the Nintendo Wii Fit system cannot be used for high velocity activities such as jumping, which may be required if working on higher level balance activities. At this time, the Nintendo Wii Fit system only has a limited number of games, and the therapist may want to address an aspect of balance that currently cannot be addressed with the activities included in the software package. Finally, the Nintendo Wii Fit system may not be sensitive enough to accurately calculate the patient's weight and exact COP, which may skew the data if the therapist is relying solely on the Nintendo Wii Fit system to keep track of progress.

Future Studies

Along with determining the effectiveness of reducing fall risk, there are many other areas that may require further research with regard to the use of the Nintendo Wii Fit system. Since, the majority of studies researched were done on community dwelling adults more research needs to be done to determine the effectiveness on a larger population of skilled nursing facility dwelling adults. It may also be important to examine the effect of the intervention of psychosocial aspects such as fear of falling. It would also be beneficial to determine if compliance and motivation play a role in results of the intervention. An emphasis needs to be placed on game selection to ascertain if the game is causing the effect or if the Nintendo Wii system in general is responsible for the positive intervention outcomes. Finally, it would be beneficial to perform a larger, multisite study using consistent outcome measures since previous studies have used a variety of outcome measures (ie, the Berg Balance Scale, Multidirectional Reach Test, Dynamic Gait Index, and Activities Specific Balance Confidence Scales).

CONCLUSION

Since increases in falls and declines in balance in the elderly population correlate to lower levels of physical activity, strategies to address balance should be incorporated into the rehabilitation session of every elderly patient.[19] The purpose of the Nintendo Wii Fit is to improve balance as well as strength, fitness, and well-being. The results of this literature review suggest that the Nintendo Wii Fit system can be used as an intervention to improve balance and decrease fall risk in the elderly. Moreover, the Nintendo Wii Fit system has been shown to be as effective as more expensive devices in measuring COP. The pros and cons of using the Nintendo Wii Fit system as an intervention must be weighed against one another when the goal is to improve balance and decrease fall risk in the elderly. As the Nintendo Wii continues to become more popular, it is important to investigate its usefulness and effectiveness in the clinic. By presenting the research on this topic, clinicians will have the ability to make an evidence-based decision when choosing whether or not to incorporate the Nintendo Wii into their rehabilitation plans.

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Call for Candidates

Dear Orthopaedic Section Members:
The Orthopaedic Section wants you to know of three positions available for service within the Section opening up in February, 2013. If you wish to nominate yourself or someone else, please contact the Nominating Committee Chair, Robert DuVall, at reduvall@bellsouth.net. **Deadline for nominations: September 4, 2012**. Elections will be conducted during the month of November.

Open Section Offices:

- **President:** Nominations are now being accepted for election to a three (3) year term beginning at the close of the Orthopaedic Section Membership Meeting at CSM 2013.

- **Director:** Nominations are now being accepted for election to a three (3) year term beginning at the close of the Orthopaedic Section Membership Meeting at CSM 2013.

- **Nominating Committee Member:** Nominations are now being accepted for election to a three (3) year term beginning at the close of the Orthopaedic Section Membership Meeting at CSM 2013.

Be sure to visit https://www.orthopt.org/content/governance/section_policies for more information about the positions open for election!

Book Reviews

Michael J. Wooden, PT, MS, OCS
Book Review Editor

Book reviews are coordinated in collaboration with Doody Enterprises, Inc.

Orthopaedic Practice (OP) is interested in having readers serve as book reviewers. Previous experience is recommended but not required. Timeliness in meeting publication deadlines is required. Invitation is only open to Orthopaedic Section members. Successful completion of each review results in the reviewer retaining a free copy of the textbook.

If you are interested, please contact Michael Wooden, Book Review Editor for OP at: michael.wooden@physiocorp.com

Effective Documentation for Physical Therapy Professionals, 2nd Edition, McGraw-Hill Companies, 2011, $58
ISBN: 9780071664042, 338 pages, Soft Cover

Editors: Shamus, Eric, PT, DPT, PhD, CSCS; Stern, Debra Feingold, PT, DPT, MSM, DBA

Description: This updated book presents general principles of documentation for physical therapy services and how to effectively manage health information to receive reimbursement. The previous edition was published in 2004. **Purpose:** The purpose is to provide current information on documentation to avoid denial of medically necessary physical therapy services. The book highlights common errors that result in denial of skilled physical therapy and describes how to organize the medical record and choose the most appropriate content. The authors meet their objectives, providing a valuable resource on what, how, and why to document. **Audience:** It is written for physical therapy professionals at all experience levels. It provides a solid foundation for students as well as review and reflection for more experienced clinicians. In today's healthcare environment, it is imperative that physical therapists document effectively. The authors have selected an extensive group of professionals to contribute the most current knowledge to the book. **Features:** The first four chapters summarize the general rules for health information management and the principles, guidelines, and requirements for effective documentation. It then dives into special topics including home health and pediatric documentation, as well as legal issues and utilization review. The chapter outlining Medicare and non-Medicare content principles is well done with multiple case studies, sample problem lists, goals, and treatment notes to enhance learning. Throughout, Author's Notes offer clarifications and exceptions to the rule. Chapters conclude with up-to-date references, essential for this topic, and review questions. The appendixes that follow the chapters serve as a convenient reference for use in the clinic, and include abbreviations, ICD-9 code terms, Medicare and HIPPA forms, and goal writing and documentation content exercises. **Assessment:** This is a valuable and practical book for students and experienced clinicians alike. This update is justified due to the dynamic quality of the material. With reimbursement decreasing for skilled physical therapy services, it is imperative that documentation is detailed and accurate about what is billed. I strongly recommend this book for physical therapy programs and as an essential update for all practicing clinicians.

Lauren Y Perrone, MPT, OCS
Head 2 Toe Physical Therapy

Physical Therapy Management of Low Back Pain: A Case-Based Approach, Jones & Bartlett Learning, 2013, $66.95
ISBN: 9780763779450, 339 pages, Soft Cover

Editors: Chevan, Julia, PT, PhD, MPH, OCS; Clapis, Phyllis A., PT, DHSc, OCS

Description: This book describes one patient with acute back pain and then follows him through various physical therapy approaches. **Purpose:** The purpose is to provide information and serve as a resource for physical therapy models for treating acute low back pain. This book is valuable because back pain is prevalent in our society and many individuals with back pain seek physical therapy treatment. **Audience:** It targets physical therapy students, but it also is a good reference for experienced clinicians. Knowledgeable authors succeed in presenting the information to a broad audience. Students have the advantage of discussing approaches in class, while practitioners can benefit by learning about less familiar models or from comparing approaches. **Features:** Nine chapters independently address a defined case based on a particular approach. Treatment concepts covered include Cyriax, Kaltenborn-Evjenth, Maitland, McKenzie, Mulligan, Paris, osteopathic, movement system impairment syndrome, and treatment-based classification. The physical therapy regimes are compared, but one is not considered more useful than another. The introduction refers to a Wall Street Journal article in which the reporter concluded, "physical therapy is still as much art as science," after going to five different practitioners for the same diagnosis and receiving five different treatments. This book describes nine approaches for treatment of acute back pain, but does not clarify how one could reach a conclusion different than the reporter's about the wide range of possible treatments for the same diagnosis. Some authors explain the evaluation and treatment components more clearly than others do. While each approach includes information about frequency and duration for full recovery, this is a theoretical case without real-world outcomes. **Assessment:** This book is successful as a student manual and professional resource for different methods to treat low back pain. The case approach uniquely shows how different physical therapy models can be applied to the same patient.

Karin J Edwards, MSPT
Providence Health & Services

Legal, Ethical, and Practical Aspects of Patient Care Documentation: A Guide for Rehabilitation Professionals, 4th Edition, Jones & Bartlett Learning, 2013, $55.95
ISBN: 9780763799106, 275 pages, Soft Cover

Author: Scott, Ronald W., PT, JD, EdD, LLM, MSBA

Description: This book describes professional standards for documentation, use of documentation in legal proceedings, ethical considerations in documentation, and strategies to minimize risk of malpractice liability for rehabilitation professionals. It provides useful and basic guidance in a variety of clinical scenarios from informed consent prior to manual therapy to documenting medical necessity for third-party reimbursement. The previous edition was

published in 2005. **Purpose:** The purpose is to give rehabilitation professionals and students a framework for meeting the basic standards of documentation to improve the quality of patient care and reduce the risk of adverse legal consequences. The author achieves this through defining malpractice and liability, describing common documentation pitfalls, discussing documentation for a wide variety of clinical scenarios, and illustrating the legal and ethical consequences of poor documentation. **Audience:** The author states the book is written to guide health professionals and students. Although the documentation examples are written mainly from the perspectives of PTs and MDs, the book can be helpful for other professions in rehabilitation settings. It is a good reference for new professionals, clinical managers, and any other people with the responsibility of risk management. **Features:** Each of the six chapters contains a summary as well as a focus on ethics discussion, references and suggested readings, review case studies, and discussions of the review case studies. The chapter on "Problems, Errors, and Suggestions" is most immediately applicable to therapists and provides specific examples of common documentation mistakes, their legal and ethical consequences, and strategies to prevent them. Time constraints on orthopedic physical therapists are ever-present in the effort to provide the most cost-effective care, but, as the author points out, they must also realize that the quality of documentation is held to higher standards than ever before. The author provides helpful examples of incorrect documentation strategies, as well as correct ones, and, where necessary, a framework for documentation forms. These forms, including incident reports, informed consent, release of records, peer review worksheets, and HIPAA privacy notification, provide practical guidelines. The glossary provides quick descriptions of common legal terms that are devoid of complicated legal jargon, which makes them easier to understand. The author references court cases in certain parts of the book, and more such references as they relate to inadequate documentation would further motivate readers to make recommendations a priority. **Assessment:** This is a good guide to documentation standards for outpatient clinics and hospital rehabilitation departments, among others. It illustrates the consequences of our failure to communicate effectively and accurately in our documentation and how it can be career changing under the scrutiny of the legal system. It is each therapist's professional responsibility to document effectively and know the highest standards of current practice. This book provides the guidelines for these standards. The updated edition is needed in the evolving landscape of documentation expectations.

Monique Serpas, DPT
HealthReach Rehabilitation Services

Multidisciplinary Management of Migraine: Pharmacological, Manual, and Other Therapies, Jones & Bartlett Learning, 2013, $110.95
ISBN: 9781449600501, 441 pages, Soft Cover

Editors: Fernandez-de-las-Penas, Cesar, PT, DO, PhD; Chaitow, Leon, ND, DO; Schoenen, Jean, MD, PhD

Description: This book offers readers a comprehensive multidisciplinary approach to addressing patients with migraines. **Purpose:** The purpose is to offer readers a comprehensive reference on the understanding and treatment of migraines. It therefore not only includes the pharmacological aspects of migraine management, but also several nonpharmacological approaches. **Audience:** The book is designed for use by clinicians in any medical specialty who treat patients with migraines and other headaches. Practitioners who have an understanding of pain science will better appreciate the first section of the book, which is highly technical and focuses on pain mechanisms related to migraines. However, this should not deter clinicians or students who are less familiar with pain mechanisms or pain science from adding this book to their personal library. The chapters are very educational and demonstrate the need for medical professionals to understand pain processes to improve their treatment of these patients. **Features:** The first of the book's four main sections covers foundational information, including the epidemiology, differential diagnosis, and pain science. The second section covers all aspects of pharmacological management. The third and fourth sections cover the manual therapies and other complementary and alternative medical therapies. All chapters are well referenced and written by experts in their respective areas. For practicing clinicians, the third and fourth sections are the most relevant as they cover the various options for treatment of patients with migraines. Several chapters include pictures and clear descriptions of specific treatment techniques. The best quality of this book is its insights into the various disciplines that can be involved in treatment of migraines. Granted, some may not be available in all areas of the country, but the book at least offers practitioners options for their patients should they need additional resources. **Assessment:** A book that covers a single topic from foundational pain sciences and pathophysiology to diagnosis, differential diagnosis, and all aspects of treatment is difficult to find. This one covers all areas in enough detail to provide a great resource for those who treat this patient population.

Michelle Finnegan, DPT, OCS, MTC, CMTPT, FAAOMPT
Bethesda Physiocare

Congratulations to the 2012 Honors and Awards Recipients

Each year APTA honors outstanding achievements on the part of its members in the areas of overall accomplishment, education, practice and service, publications, research, and academic excellence. Award recipients are recognized in June with a celebration and reception at APTA's Annual Conference and Exposition.

The Orthopaedic Section, APTA would like to congratulate our members who were recently selected for these honors and awards. This year's winners include:

Catherine Worthingham Fellows of APTA
Helene Fearon, PT, FAPTA
Rob Landel, PT, DPT, OCS, CSCS, FAPTA
Kevin E. Wilk, PT, DPT, FAPTA
Rita Wong, PT, EdD, FAPTA

FA Davis Award for Outstanding Physical Therapist Assistant Educator for Outstanding New Academic Faculty Member
Carol Ann Schaefer Clayton, PT, PhD

Signe Brunnstrom Award for Excellence in Clinical Teaching
Karla Ann Bell, PT, DPT, OCS

Lucy Blair Service Award
Connie Davis Hauser, PT, DPT, ATC
Stephen C.F. McDavitt, PT, DPT, MS, FAAOMPT
Gina Maria Musolino, PT, MSEd, EdD
Philip Tygiel, PT, MTC

Marilyn Mofatt Leadership Award
Patricia "Pat" McAdoo, PT, MEd

Outstanding PT/PTA Team Award
Greg Sills, PTA, BS

Chattanooga Research Award
Kathryn E. Roach, PT, PhD

Dorothy Briggs Memorial Scientific Inquiry Award
Alexis A. Wright

Helen J. Hislop Award for Outstanding Contributions to Professional Literature
Lynn Snyder-Mackler, PT, ScD, SCS, FAPTA

Jules M. Rothstein Golden Pen Award for Scientific Writing
Paul F. Beattie, PhD, PT, OCS, FAPTA

OCCUPATIONAL HEALTH

SPECIAL INTEREST GROUP

GREETING OHSIG MEMBERS!

We hope this finds you well, enjoying the first days of summer…or nearly summer! A few updates from the Occupational Health SIG.

Announcing the First International FCE Research Meeting

The First International FCE Research Meeting in Haren, The Netherlands will take place October, 25, 2012. This is a great opportunity to participate with top researchers and others in the area of FCE.

A brief look at the agenda and speakers:

- New research
  1. Does test evaluator's fear of injury influence maximal lifting capacity? A triple blind RCT. *Sandra Jorna-Lakke*
  2. Cost-benefit of work-related multidisciplinary rehabilitation for patients with MSDs: does employment status matter? *Marco Streibelt*
  3. Can submaximal physical and functional capacity be detected in patients with chronic pain? A systematic review. *Suzan van der Meer*
  4. Reliability, agreement and safety of FCE in patients with WAD. *Maurizio Trippolini*
- Pros/Cons for normative values for FCE. A debate. *Remko Soer and Paul Kuijer*
- FCE as outcome
  1. Gender differences in capacity ratings predicting RTW for patients with MSDs. *Marco Streibelt*
  2. Decline of functional capacity in healthy aging workers. *Remko Soer*
  3. Longitude assessment of physical capacity in a cohort study on early osteoarthritis of the hip and the knee. *Andre Bieleman*
  4. Does the performance of an FCE lifting test differ between employees on sick leave due to MSDs in physically demanding work and their health counterparts? *Paul Kuijer*
  5. Deconditioning in workers with chronic MSD pain: does work matter? *Remko Soer*
  6. Client's perspective on the utility of FCE for the assessment of physical work ability, prognosis for work participation and advice on RTW. *Willemijin Pas*
- Pre-employment FCE
  1. Pre-employment functional assessments predict MSD injury risk associated with manual handling in coal miners. *Jenny Legge*
  2. Job-specific FCE protocols for household waste collectors: development and reproducibility. *Vincent Gouttebarge*
- One for all, or all for one?
  1. Debate
  2. Generic or specific FCE protocols? *Vincent Gouttebarge and Doug Gross*
- Where do we go from here?
  - o 1. Open discussion
  - o 2. FCE research agenda. *Doug Gross and Michiel Reneman*

Please find a Message from Michiel Reneman:

Dear colleagues,

I am happy to announce that we will hold the FCE research meeting on October 25th, 2012, in Haren, The Netherlands. The program will consist of a mix of oral presentations and discussions, as well as 2 lively debates, each introduced by 2 colleagues who have agreed to disagree with another.

Note: Details on the program, directions to our rehab center, and dinner are posted on our Web site at: http://www.umcg.nl/nl/umcg/afdelingen/centrumvoorrevalidatie/researchonderwijs/postwdpimeetingfce/Pages/default.aspx

All new information will be posted on this Web site. Shortly, we will also have a link on the WDPI Web site. Registration is required. Hope to see you all!

On behalf of Berry van Holland, co-organizer, and Doug Gross, co-chair,

Regards,
Michiel Reneman

Announcing Second Scientific Conference on Work Disability Prevention and Integration; Healthy Aging in a Working Society

October 22-24, University Medical Center Groningen, The Netherlands

The FCE Research Meeting will follow the WDPI meeting. For more information on WDPI, go to the following:

http://wencke4.housing.rug.nl/documenten/medici/Internationale_Conferenties/WDPI%202012/WDPI_2012.htm

Announcing Human Factors and Ergonomics Society Annual Meeting

The Human Factors and Ergonomics Society announces the 56th Annual Meeting to be held October 22-26, 2012 at the Westin Boston Waterfront in Boston, MA. Additional details are available at http://www.hfes.org//Web/HFESMeetings/2012annualmeeting.html.

OHSIG Election

The office of President is up for election later this fall. The term is 2013-2016. If you are interested in running, contact Jill Galper, Nominating Committee Chair at Jill.Galper@imxmed.com.

Thank you to Doug Flint, DPT, OCS, for his article in this issue of OPTP on Post Offer Pre-Employment Testing

In his article, Doug describes the benefits of a post offer testing program. If you are not involved in post offer testing for employers in your area, it is well worth your consideration. Post offer testing needs to comply legally, needs to objectively represent the job functions, and be consistently applied. Thanks to Doug for a look at the benefits of such a program.

YOUR OHSIG BOD

As always, your BOD members are listed on the Orthopaedic Section Web site. We welcome your feedback!

Professional Regards,
Margot Miller, PT
OHSIG President

Post Offer Pre-employment Testing

Douglas P. Flint DPT, OCS
Intermountain Health Care, Ogden, UT

Musculoskeletal disorders involving employees have represented the leading cause of injury and illness in American Industry. In 2003, according to the Bureau of Labor Statistics, there were 374,700 work-related back injury cases alone.[1]

Since Don Chaffin's work in the early 1970s at the University of Michigan, post offer pre-employment testing has been a popular strategy for reducing injuries and lost hours due to musculoskeletal disorders. Chaffin found workers were 3 times more likely to be injured on the job when not having demonstrated the required physical work demands for a specific job.[2]

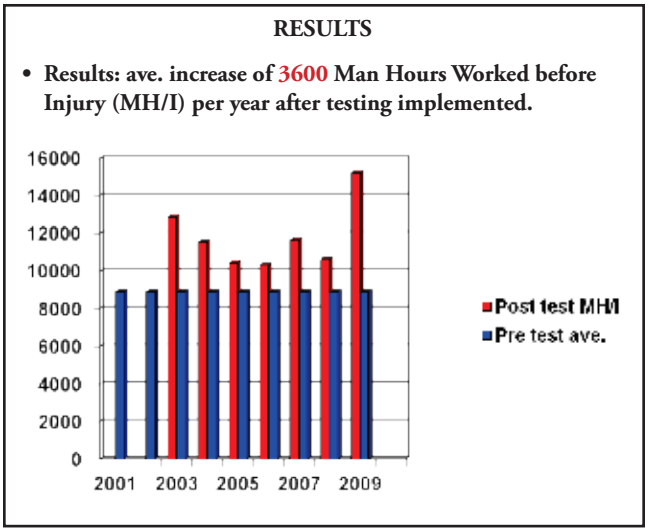
Surprisingly, until now, there has been little formal research since the early 1970s in evaluating the outcomes of physical capability employment screening and how it affects specific company costs and lost time due to injury.

This paper will show how post offer pre-employment testing can benefit employers in 3 specific ways. First it can reduce the cost of work related injuries by increasing the man hours worked without an injury and decreasing the health care costs related to work related injuries by helping to hire the right person at the right time for the right job. Second this test creates clear objective criteria for workers to return safely to their job following an injury. Third it can be used in conjunction with "fit for duty" testing which can assess whether a worker demonstrates behaviors that question their physical ability to do their job.

In 2000 I was asked to work with a local food warehousing company to help reduce the number and severity of injuries in their Order Selector job position. We reviewed the types of injuries and the rate of turn over for this specific job position by reviewing their OSHA logs. We identified that the largest number of injuries were indeed musculoskeletal and mostly low back related. We looked at the man hours worked per injury data and averaged it for the previous 3 years. This average was found to be 8600 man hours worked without an injury. With this information, we could compare the effect of implementing a post offer pre-employment test for the Order Selector job position.

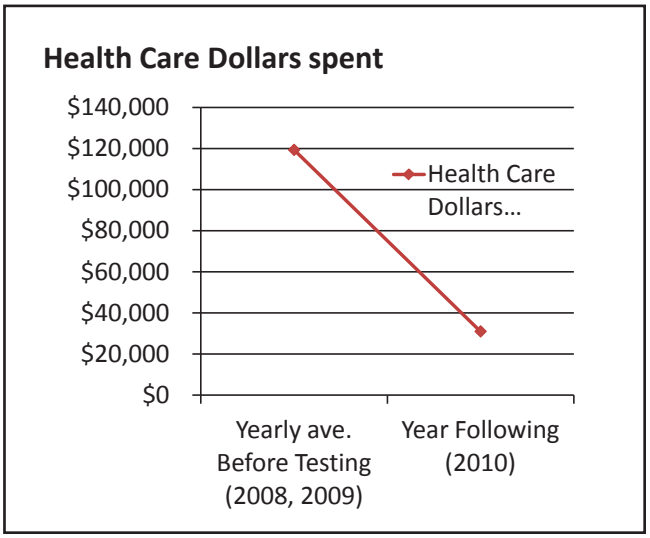
The job specific physical demands were identified by a job-site analysis. From this analysis a post offer test was created and implemented in 2003. In 2009 we reviewed the results of testing with the company. We had tested over 1200 people. We reviewed the man hours worked without an injury for the years after testing and found that it increased to an average of 3600 hours without an injury. This is important because it equates to over 1½ full time employee equivalents and thus significantly increases their productivity (Table 1).

Table 1.



In 2009, I was approached by a local school district that was having a high number of injuries with their food service technicians. We reviewed the health care cost of their work related injuries and found that for the 3 previous years the health care cost averaged $119,343. By following the same process of performing a job analysis as the food warehousing company, the job specific physical demands for this job were identified, and a post offer pre-employment test was created and implemented in 2009. In 2010 their health care costs for work related injuries dropped to $30,964 resulting in an $88,379 reduction in cost (Table 2).

Table 2.



We are waiting for 2011 data to be collected to validate this trend of lower costs.

The next benefit of post offer pre-employment testing is the clear criteria for return to work following an injury. This might be better understood by considering what employers will be faced with in the near future.

"The new Americans with Disabilities Act as amended will effect over 880,000 employers across the United States. In its analysis of the cost of the new legislation, the Equal Employment Opportunity Commission (EEOC) estimated that these employers will experience an incremental increase in requests for reasonable accommodation of between 2 million to 6.1 million over the next 5 years. Each of these requests must, by law, be responded to in writing, documented, and resolved. Ergonomic evaluation experts will play a significant role in an employer's response to these requests.[3]

When companies have implemented a valid post offer pre-employment test that clearly identifies the core essential job specific physical demands of a particular job position, it has already addressed what the return-to-work (RTW) criteria for a specific job involves. This will help companies focus their resources on accommodating tasks that are not core essentials rather than trying to determine what the core essentials are at that time. A post offer pre-employment test also creates a consistent fair process for evaluating these requests for reasonable accommodations.

The third benefit of post offer pre-employment testing is the ability for it to be used for fit-for-duty (FFD) testing. Many employers have stated that they have a significantly higher rate of injury with employees returning to their jobs following a leave of absence. Although it is not allowed to mandate that an employee must perform a FFD test prior to returning to work following a prolonged leave of absence, it is within the employer's right to request a FFD test on any employee who demonstrates reasonable suspicion of being unable to safely perform their job duties. For example, this could be evidenced by a supervisor observing a recently returning employee having difficulty going up stairs or bending or lifting. This would be considered reasonable suspicion and could trigger a FFD test.

In summary, these studies have shown that post offer pre-employment testing can be beneficial to the employer by reducing costs and increasing man hours worked without an injury. To develop a competent post offer pre-employment test, it is essential to have a valid job description that identifies the core essentials and job specific work tasks of a particular job. This will, in turn, set the foundation for an objective and clear Return-to-Work criteria and Fit-for-Duty testing. Post offer pre-employment testing is also beneficial to the employee by ensuring the employee is physically capable to safely perform the duties of their job.

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3. ADAAA sec. 12111. Definitions (2) Covered entity, (5) employer.

PERFORMING ARTS

SPECIAL INTEREST GROUP

PRESIDENT'S MESSAGE

Welcome to the PASIG news for 2012. We have had a very active 2012 following success in our 2012 CSM programming. We are actively working on our resource page on the Orthopaedic Section Web site and organizing informative content for our monthly citation blasts.

The PASIG is looking for your feedback and your contribution of content regarding our resource page on the Orthopaedic Section Web site at www.orthopt.org. Check it out as it contains valuable information and resources related to all aspects of performing arts physical therapy.

Also, please register on the PASIG database using the membership profile so that your clinical information is accessible in our membership database. This is vital in helping our performing artists find skilled clinicians in their respective areas.

The elections for the 2013 officer positions will take place in November 2012. We are currently seeking nominations for a Vice President and Nominating Committee member. If you are interested or would like to nominate someone for one of these two positions, please contact our Nominating Committee Chairperson, Laura Becica, at lbecica@physioarts.com.

The PASIG Research Committee, under the direction of Annette Karim, continues to provide a monthly citation blast that provides an update about current happenings in the PASIG as a well as an annotated bibliography related to performing arts specific injuries. If you are interested in receiving this communication, please sign up to be a PASIG member as part of the Orthopaedic Section.

If you have any questions related to the PASIG or would like to become more actively involved, please contact me at Joconnell@athletico.com.

Sincerely,
Julie O'Connell, DPT, PT, ATC
PASIG President

PERFORMING ARTS CONTINUING EDUCATION

Performing Arts
Independent Study Courses
Orthopaedic Section Independent Study Course.
20.3 Physical Therapy for the Performing Artist
Monographs are available for:

- Figure Skating (J. Flug, J. Schneider, E. Greenberg)
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Orthopaedic Section Independent Study Course.
Dance Medicine: Strategies for the Prevention and Care of Injuries to Dancers
This is a 6-monograph course and includes many PASIG members as authors.

- Epidemiology of Dance Injuries: Biopsychosocial Considerations in the Management of Dancer Health (MJ Liederbach)
- Nutrition, Hydration, Metabolism, and Thinness (B Glace)
- The Dancer's Hip: Anatomic, Biomechanical, and Rehabilitation Considerations (G. Grossman)
- Common Knee Injuries in Dance (MJ Liederbach)
- Foot and Ankle Injuries in the Dancer: Examination and Treatment Strategies (M. Molnar, R. Bernstein, M. Hartog, L. Henry, M. Rodriguez, J. Smith, A. Zujko)
- Developing Expert Physical Therapy Practice in Dance Medicine – (J. Gamboa, S. Bronner, TJ Manal)

Contact the Orthopaedic Section at:

Or call 1-800-444-3982

PRESIDENT'S MESSAGE

Many years ago, at a pain management meeting, a presenter reported that "all chronic pain was in the patient's head." After the furor of the audience calmed down, he went on to explain that you cannot have pain without a brain and the brain lives in the head. Over the past decade, more study has been given to this concept and that charlatan of 30 years ago is now considered a wise man. Fear avoidance, stress, pain belief screening, abuse, job satisfaction, etc all contribute to the patient's persistent pain presentation.[1] I am pleased that two members have come forward to share their clinical experiences and literature reviews with us in this newsletter. Thank you Carolyn McManus; her article is printed below. Watch for Nate Sorum's literature review in the next newsletter.

Hope you have a happy, safe, and pain free summer.

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Stress-Induced Hyperalgesia: Clinical Implications for the Physical Therapist

Carolyn McManus, PT, MS, MA
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INTRODUCTION

Following a motor vehicle accident, my patient, Ms. S, carried her daughter into an emergency room unaware of her own injuries. Only after learning that her daughter's injuries were not life threatening did she experience the pain in her feet from glass fragments lodged in her shoes. Years later, Ms. S was diagnosed with fibromyalgia and now struggles with the opposite impact of stress on pain. Daily life stress increases her pain. Her two experiences demonstrate the paradoxical role stress plays in pain perception.

The intensity or aversiveness of a stressor may influence the amplification or suppression of pain. Highly intense stress may inhibit pain. Termed "stress-induced analgesia," this phenomena was first described by Dr. Henry Beecher, a military anesthesiologist, who collected data on pain complaints of severely wounded soldiers during World War II.[1] Two thirds of the men with extensive soft tissue injuries, penetrating wounds or compound fractures, said they had little or no pain. Only 27% requested pain medication. Recent research demonstrates that both opioid and non-opioid intrinsic pain inhibitory systems activate to suppress pain under intense-stress conditions.[2]

Stress may also amplify pain conditions. In clinical settings, stress is implicated in the transition from acute to chronic back pain,[3] plays a role in the exacerbation of fibromyalgia,[4] rheumatoid arthritis,[5] pelvic pain,[6] and irritable bowel syndrome,[7] and can have an adverse effect on surgical outcomes.[8] In addition, individuals with a history of abusive childhoods are at an increased risk of chronic pain in adulthood relative to individuals not reporting childhood abuse.[9]

STRESS-INDUCED HYPERALGESIA

An increase in pain sensitivity caused by stress, termed "stress-induced hyperalgesia" (SIH), is an area of current laboratory research. In rodent studies, hyperalgesia has been shown to result from repeated exposure to stress such as swim[10] and sound stress,[11] chronic restraint,[12] and social defeat.[13] In rats, water avoidance stress produced mechanical hyperalgesia in skeletal muscle and an approximate 34% decrease in the mechanical threshold of muscle nociceptors, 65% increase in the number of action potentials produced by a fixed intensity suprathreshold stimulus and 67% increase in nerve conduction velocity.[14] Rats subject to neonatal stress demonstrated persistent mechanical hyperalgesia and nociceptor sensitization in adulthood.[15] In the mature rats, mechanical threshold of muscle nociceptors was reduced nearly 31% and conduction velocity increased by approximately 28%.

NERVOUS SYSTEM MECHANISMS CONTRIBUTING TO SIH

Peripheral Mechanisms Contributing to SIH

Catecholamines, secreted by the adrenal medulla in response to stress, may act in the periphery to promote hyperalgesia. In rats, local administration of epinephrine induces transient mechanical hyperalgesia in the absence of nerve injury via action of the beta-adrenergic receptors.[16] Exposure to elevated levels of epinephrine has also been shown to enhance the pronociceptive effects of immune mediators[17] and induce IL-6 synthesis in skeletal muscle.[18] The IL-6 synthesis is significant because of its role in producing mechanical hyperalgesia in skeletal muscle and possible contribution to the transition from acute to chronic pain.[19]

Central Mechanisms Contributing to SIH

Chronic social stress in rats has been shown to induce spinal neuroinflammation, resulting in a decrease in mechanical nociceptor threshold, sensory hypersensitivity, and long-lasting anxiety-induced hyperalgesia.[13] Forced swim stress in rats has been shown to induce mechanical hyperalgesia and a shift in excitatory and inhibitory mechanisms at the spinal level.[10] A decrease and delayed inhibitory neurotransmitter release in the spinal cord initiated hyperalgesia, while an increase excitatory neurotransmitter release maintained the SIH.

The dorsomedial nucleus of the hypothalamus (DMH) plays a critical role in neuroendocrine responses to stress and has direct and indirect connections to the rostral ventralmedial

medulla (RVM), a brainstem region active in the descending modulation of nociceptive transmission in the dorsal horn.[20] In rats, disinhibition of the DMH triggered behavioral hyperalgesia and a robust activation of pain-facilitating neurons and suppression of pain-inhibiting neurons in the RVM.[21]

CLINICAL IMPLICATIONS OF SIH

Physical therapy interventions for the treatment of pain depend on an accurate understanding of underlying mechanisms. These mechanisms are complex, multi-factorial, and under continual clinical and laboratory investigation. Current evidence suggests that stress plays a role in hyperalgesia and chronic pain. Although mechanisms underlying SIH come from rodent studies, results of these laboratory investigations combined with evidence of the role of stress in clinical populations invite a thoughtful consideration of the role stress plays in the pain complaints of patients. Stress-induced hyperalgesia could contribute to an elevated pain level and more prolonged healing process than expected in a stressed patient. Pain from an injury in a stressed individual could persist because of SIH and potentially contribute to a chronic pain condition.

Physical therapists may wish to consider a patient's stress level when evaluating and assessing mechanisms of a pain complaint. Inquiring about stress levels may be a judicious choice when pain complaints appear more severe than would otherwise be expected for the mechanism of injury or pain persists beyond a reasonable time frame for healing. Also, should a patient disclose a history of childhood abuse, physical therapists need to be aware that preliminary findings suggest the possibility that early trauma may have an enduring impact on the nociceptive system.

The direct influence of a patient's stress level on pain is not easily identified and quantified. A patient's self-report of stress is limited by his or her self-awareness and self-assessment skills. Some patients may accurately identify and be comfortable discussing life stressors and their limited skills to manage stress. Others may not recognize or be willing to disclose difficult life circumstances or suggest their coping is impaired. A short assessment tool, such as the Perceived Stress Scale, may help both patient and clinician identify a patient's stress level. The Perceived Stress Scale is a valid, reliable, and widely-used 10-item measure of self-appraised stress.[22,23]

If a patient acknowledges high stress levels and/or the physical therapist makes the clinical judgment that stress plays a role in the patient's pain complaints, treatment choices to address the pain escalating influences of stress should be included in a plan of care. The following treatment approaches warrant consideration:

1. Neurophysiology pain education

Neurophysiology pain education provides patients with an understanding of key factors that give rise to the experience of pain. Topics covered include the anatomy of the nervous system, peripheral and central sensitization, and how the brain processes and regulates nociceptive information. A recent systematic review of neurophysiology pain education concludes that for chronic musculoskeletal disorders, this education strategy may have a positive impact on pain, disability, catastrophizing, and physical performance.[24] This comprehensive educational approach could, in part, reduce a patient's stress level.

2. Progressive muscle relaxation training

Progressive muscle relaxation has been shown to reduce subjective and physiological indices of stress[25] and may help patients increase coping and control of pain.[26] In addition, authors of a Cochrane Database Review conclude moderate evidence exists in favor of progressive relaxation for providing a large positive effect on pain and behavioral outcomes in patients with chronic low back pain.[27]

3. Diaphragmatic breathing

Preliminary investigations suggest slow, deep breathing may contribute to a reduction in sympathetic nervous system activity and pain perception.[28,29] This treatment strategy may prove especially helpful to patients with fibromyalgia, a population shown to have smaller chest expansion measurements and lower maximal inspiratory and expiratory pressures compared to healthy controls.[30]

4. Body awareness training

A patient's ability to be aware of the body is necessary for the self-regulation of the nervous system. Many patients have little or no body awareness. Others are afraid to pay attention to their physical experience because of pain. Unable to bring awareness to the body in a skillful manner, they are unable to observe and successfully modulate the stress reaction. Strategies that promote body awareness such as the mindful body scan,[31] gentle yoga,[32] and tai chi,[33] promote a healthy mind-body relationship and may contribute to a patient's ability to observe and reduce the stress reaction.

5. Aerobic exercise

Aerobic exercise has been shown to improve mood and reduce anxiety and panic.[34] In addition, physical fitness may act to mitigate adverse effects of psychosocial stress and reduce inflammatory cytokine response to acute mental stress.[35]

6. Psychosocial interventions tailored for delivery by physical therapists

Physical therapists providing standard physical therapy treatment combined with a psychosocial intervention to patients with chronic low back pain was shown to reduce risk factors for pain and disability, reduce the use of the health care system, reduce the use of pain medication, and improve return-to-work outcomes.[36] This physical therapist-delivered, psychosocial intervention included the targeted treatment of psychosocial risk factors, graded activity setting, exposure to feared activity, goal setting, problem solving, and motivational enhancement. This structured psychosocial intervention could conceivably contribute to reducing a patient's stress level.

In addition, physical therapists may consider referring patients to additional stress management resources including cognitive behavioral therapy[37] and mindfulness based stress reduction programs.[31,38]

CONCLUSION

Stress is recognized to both suppress and amplify pain. Intense, life-threatening stress may inhibit pain, while mild or moderate stress may amplify pain. Recent evidence from laboratory investigations of SIH suggests stress can amplify nociceptive system sensitivity through both peripheral and central nervous

system mechanisms. Physical therapists have the opportunity to employ evidence-based stress reduction strategies to reduce possible SIH in patients with persistent pain conditions. Additional physical therapy treatment approaches to reduce patient stress and the impact of those strategies on pain and function create an opportunity for future research.

ACKNOWLEDGEMENTS

Special thanks to John Garzione, PT, Kim Bennett, PT, PhD, Rich Bettesworth, PT, and Teresa Dean, PT, for their thoughtful review and suggestions for this article.

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FOOT & ANKLE

SPECIAL INTEREST GROUP

MESSAGE FROM THE FASIG PRESIDENT

Happy summer to all FASIG members! We are glad you are contributing to our SIG, first by checking out this column and then, by considering how YOU can grow with us! The FASIG is about 600 members strong and is comprised of some of the best researchers and clinicians in the world...folks who spend much of their time on the foot and ankle as a particular region of study. I, for one, am consistently amazed by the breadth and clarity of the research that our members continue to publish!

Our SIG is devoted to bringing that research directly to your desk, as evidenced by the article submitted this month by lead author, Steve Pettineo. Steve is a clinician, instructor, and researcher who has published some intriguing research about capsulitis at the ankle. Like you, his observations began to generate questions about how physical therapists should assess and then treat orthopaedic conditions. Then, he went out and answered those questions.

Orthopaedic Physical Therapy Practice (OPTP) is often the source of early research concepts and effectively becomes a starting point for more in-depth discussions and ultimately, large and extensive studies. Try placing yourself in Steve's shoes and consider developing a plan to answer the questions floating around in *your* head. This column is the perfect place to start! Call or E-mail me with your thoughts, questions, or ideas and let's get rolling! In the meantime, please enjoy Steve's work!

FYI: Dr. Chris Neville, the chair of the FASIG "Entry-level Curriculum Content Task Force" has recruited members for the Task Force and they are now in the process of developing the framework they will use to develop the model foot and ankle curriculum for entry-level physical therapy programs. The Task Force will present preliminary recommendations at the 2013 CSM in San Diego. The FASIG leadership is excited to finally see this project started. If you would like to be involved with the Task Force, please contact Chris or me.

Best regards,
Clarke Brown,
FASIG President

Adhesive Capsulitis of the Ankle

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Adhesive capsulitis is a diagnosis most commonly associated with frozen shoulder. Though volumes have been written in books and the peer reviewed literature on adhesive capsulitis of the shoulder, there is a dearth of information regarding adhesive capsulitis of the ankle (ACA). Though it is often misdiagnosed as post-traumatic arthritis, adhesive capsulitis of the ankle is a distinct entity that is characterized by a global loss of capsular volume in the talocrural joint.

On a cellular level, the pathophysiology of the shoulder and ankle adhesive capsulitis is similar. Initially, there is an infiltration of lymphocytes and synovial inflammatory cells in the joint capsule. Over a period of 3 to 4 weeks the capsular fibrous layer becomes thickened and the presence of new collagenous tissue inhibits joint range of motion.[1-3] This is most pronounced in the anterior and posterior capsule recesses, hence the loss of dorsiflexion and plantarflexion mobility seen clinically.

The limited case studies that are found in the literature suggest ACA often occurs following trauma such as ankle or pilon fractures and recurrent ankle sprains.[2,4,5] Because many of these patients have suffered trauma requiring open or external fixation, a large percentage require prolonged immobilization. More research is needed to determine if these factors contribute to idiopathic ACA.

Diagnosis of adhesive capsulitis of the ankle has historically involved invasive testing to confirm the diagnosis. Radiographs are nonspecific to the capsular tissue involved in the diagnosis of ACA and, therefore, have no benefit in assisting with diagnosis. In fact, given the number of posttraumatic ACA cases, it has been our experience that x-rays can lead many physicians to discount the patient's complaints of pain and stiffness as "arthritis."

In 1976 Goldman et al[3] proposed arthrography as the test of choice for the diagnosis of adhesive capsulitis of the ankle. These authors suggested that a decrease in ankle joint volume from a normal of 10-25 ml to 3-5 ml total was indicative of ACA. A recent clinical review of ACA has supported the use of MRI for diagnosis of ACA.[6] Specifically, decreased joint fluid and thickening of the anterior and posterior capsule seen on MRI images, may indicate adhesive capsulitis of the ankle (Figure 1A & B). The authors acknowledge that further research is necessary to establish a role for MRI in the diagnosis of this pathology.[6]

Conservative management of ACA with physical therapy has been proposed by multiple authors and is the first line of treatment at our facility. Thorough examination to identify the various impairments associated with ACA is crucial. Mobility deficits at the talocrural and subtalar joints should be treated with joint mobilization or manipulation techniques along with appropriate stretching (Figure 2A, B & C). As joint range of motion improves, mobilization with movement techniques can also be of benefit. Static progressive or dynamic splinting should be considered early on in this patient population to assist with range of motion return. Given the global loss of motion at this weight-bearing joint, associated impairments during gait and balance dysfunction will be slow to improve. It is important to educate the patient on the importance of compliance with their home exercise program in order to optimize their conservative outcomes.

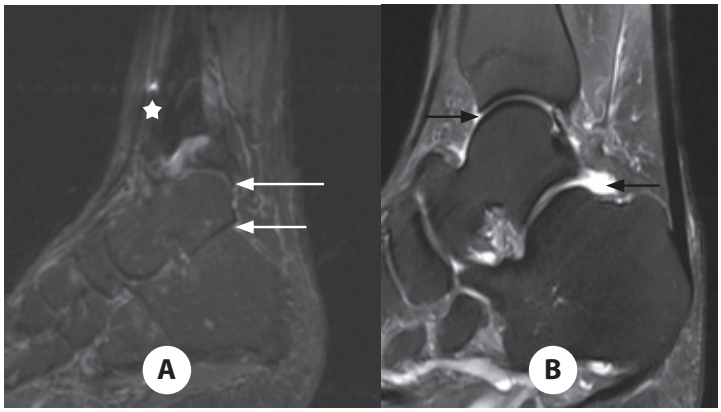

Figure 1A, B. A. Sagittal FSE T2 weighted image in a patient with postraumatic and postsurgical ACA showing complete paucity of synovial fluid in the ankle joint (long arrow) and in the posterior subtalar joint (short arrow). Note magnetic susceptibility artifact from surgical hardware (star). B. Normal ankle with normal fluid in the ankle (long arrow) and posterior subtalar joint (short arrow). Reprinted with permission from Pettineo S, et al.[6]

In the event conservative care with physical therapy is unsuccessful, arthroscopic debridement of the ankle is often necessary.[4] It is common when performing arthroscopy in a posttraumatic ankle with adhesive capsulitis to visualize the adhesions upon entering the joint. Due to the paucity of joint volume remaining in the joint space, it can be challenging to visualize the entire joint and it is necessary to use motorized shavers to debride the joint capsule adequately to gain full visualization. A typical anterior portal placement is used but a posterior arthroscopic approach has been proposed. Due to the potential for sural neuropathy, the posterior approach is not preferred. With sufficient debridement and adequate inflation of the joint, the anterior arthroscopic approach can be successful in treating ACA. Aggressive postoperative rehabilitation can begin as early as 10 days postoperatively.

In conclusion, it is important for physical therapists to recognize adhesive capsulitis of the ankle as an uncommon but distinct pathology. Manual therapy, splinting, and patient education are vital to a successful outcome. Further research is needed to assist in identification and treatment of this patient population in order to optimize outcomes.

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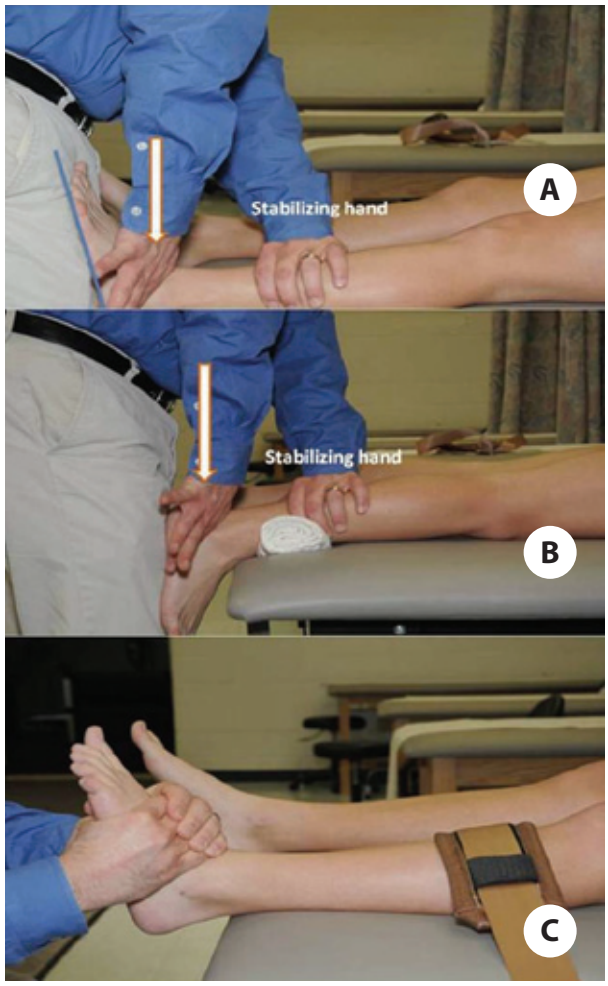

Figure 2A, B, C. From top to bottom: A. Posterior talocrural glide mobilization for dorsiflexion range of motion return. B. Anterior talocrural glide mobilization for plantarflexion range of motion return. C. Talocrural joint distraction mobilization. Reprinted with permission from Pettineo S, et al.[6]

IMAGING

SPECIAL INTEREST GROUP

As this issue goes to press, spring is giving way to summer when thoughts turn to spending more time outdoors at the sea, mountains, city, and in our backyards grilling with family and friends. We are glad you have put down your summer reading to read this newsletter. Would you please consider contributing to the newsletter? Items of interest around imaging in PT practice, education, and research are welcome. Send your ideas to dr.white@miltonortho.com

Here's an update on some of the activities we have been working on:

- Developing an online membership directory for the ISIG. Hopefully to be completed by fall.
- The ISIG would like to promote standardized imaging terminology. This has been identified as a need across health care. If you have resources/references that we can disseminate, please send them to the above address.
- Work is underway in establishing a Research Committee. We hope to have the committee before publication of the next issue of this newsletter.
- Work is well under way in developing a curriculum guide for imaging in PT education. Dr. Bill Boissonnault is heading up this project. A survey of PT educational programs is being developed. We anticipate this will be piloted in early fall.
- Dr. Douglas White is continuing to work with the American Institute of Ultrasound in Medicine on their Point-of-care Ultrasound Procedures Guideline project.
- Dialog is ongoing with the Orthopaedic Section Board on developing social media for the SIGs.

WE ARE GROWING! JOIN US!

The NEW Orthopaedic Section's Imaging Special Interest Group (ISIG) is growing! We are excited that so many individuals have joined our new SIG in such a short period of time. Please join the Imaging SIG by sending an email to Tara Fredrickson at tfred@orthopt.org.

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ANIMAL REHABILITATION

SPECIAL INTEREST GROUP

REHABILITATION FOR CANINE TOTAL JOINT REPLACEMENT

Nancy D. Doyle, MPT
Gulf Coast Veterinary Specialists, Houston, Texas

The primary goal for total joint replacement (TJR) is to relieve disabling joint pain that fails to respond to conservative treatments and/or alternative surgical procedures. Ideally the replacement should provide a pain-free joint with "normal" biomechanics for the life of the patient. Currently, total hip replacements (THR), total knee replacements (TKR), and total elbow replacements (TER) are available for canine patients; THRs are also available for feline patients.

SURGICAL CONSIDERATIONS FOR TJR

The surgical approaches to the hip, knee, and elbow for joint prosthesis implantation are slight variations of the approaches for other procedures involving those joints. The cranial approach to the hip includes a partial deep gluteal tenotomy that is repaired during closure. No other muscles or tendons are incised. The lateral approach to the knee is the same approach used to repair a distal femur fracture. A medial epicondyle osteotomy is necessary to expose the medial compartment for TATE© elbow prosthesis implantation. The osteotomy is performed in preference to transection of the medial collateral ligament and flexor muscles. The medial epicondyle must be reattached with screws during closure. The Iowa State elbow prosthesis uses a lateral approach by detaching the lateral collateral ligament and luxating the joint. The collateral ligament must be reattached during closure. Healing time for the reattached collateral ligament can be prolonged.

Ultra high molecular weight polyethylene (UHMWP) articulates with highly polished cobalt chrome in the prostheses. These materials are the same quality as those used in human implant manufacture. Implant wear is about 0.1 mm per year in humans and is anticipated to be approximately the same in dogs. Implant survival is therefore projected to be greater than 15 years for all implants. The modular hip system has both cementless and cemented versions in 16 sizes with an acetabular component (cup), a femoral stem, and a femoral head. Total hip replacement implants are available for dogs and cats weighing from 2.45 kg to greater than 75 kg. The knee prosthesis includes a cementless or cemented femoral condyle (cobalt chrome) and a tibial component with an UHMWPE articular surface. The base of the tibial component has both cementless and cemented versions. All sizes are interchangeable for dogs ranging from 20 kg to about 60 kg. The patella is not resurfaced in dogs. The cementless TATE elbow prosthesis is implanted as a single articulated humeral and radial-ulna component cartridge and is available for dogs of similar size to knee replacement candidates. The Iowa State TER components are implanted separately; the most recent generation of implants uses composite fixation (both components are cemented; the humeral component also includes cementless fixation at the condyles).

Vigorous activity is not allowed for a minimum of 6 to 8 weeks postoperatively following all procedures to facilitate soft tissue and bony healing and to allow adequate bone in-growth and/or bone on-growth at the host-implant interfaces. Excessive loading inhibits bony in-growth into the implant due to development of a layer of fibrovascular membrane between the implant and the bone. Future applications of nanotechnology may allow the clinician to monitor exact cumulative forces placed through implants and make appropriate adjustments in patient activity during postoperative healing. Until then, it is critical to maintain a balance between overexertion and judicious exercise to stimulate in-growth, minimize loss of surrounding bone mineral density, and allow earlier restoration of muscle control for dynamic support and protection of the new joint without deleterious effects.

REHABILITATION FOLLOWING TKR

Interventions for canine patients are similar to those for human patients. In our practice, rehabilitation begins immediately postoperatively, while the patient is still recovering from anesthesia, with passive range of motion (PROM) of the stifle followed by application of a compressive cold pack (CP). These treatments are continued throughout hospitalization. During the first two weeks at home, the owner completes short, slow leash walks of 10 to 15 minutes to stimulate use of the operative limb followed by PROM and CP application a minimum of 3 times per day. Early ambulation and weightbearing is expected but falls must be prevented by avoiding slick flooring surfaces and using a sling as needed to minimize the risk of complications such as prosthesis luxation, periprosthesis fractures, or collateral ligament injuries of the knee.

Two weeks postoperatively, the patient returns to the clinic for suture removal and initiation of outpatient rehabilitation. Post-op weeks 2 through 4 focus on gait retraining on the underwater treadmill, manual therapies to improve flexibility and normalize arthrokinematics, and LASER therapy to support soft tissue healing and prevent post-exercise "rebound" inflammation. Neuromuscular electrical stimulation may also be initiated if significant arthrogenous inhibition of the quadriceps is present, dependent on patient temperament and tolerance. Aquatic exercise, including underwater treadmill walking, has numerous benefits over land exercise during the early phases of rehabilitation following canine TKR. Increased AROM excursion of all joints is demonstrated compared to gait on land. Weightbearing on the hind limb is decreased by ~62% (depending on the patient's body mass index and conformation) when the water in the underwater treadmill chamber is filled to the level of the patient's greater trochanter. This weight reduction decreases the compressive forces through the joint and prosthesis and helps protect the collateral ligaments during the early phases of healing and remodeling. Water provides a safe exercise opportunity for high-energy dogs with "cabin fever" and

thereby may decrease the risk of complications due to excessive high-level activity. Finally, when compared to swimming, walking in water follows the principle of specificity of training while targeting the quadriceps and allows better control of exercise intensity.

Land-based exercises are begun 4 weeks postoperatively, with the inclusion of a home exercise program (HEP) tailored to address each patient's specific needs through progressive resistive exercise and proprioceptive retraining. Unless complications exist or the client chooses to continue, the patient is typically discharged to a home program at postoperative week 8. Discontinuation of clinical rehabilitation has been largely due to constraints of clients' time and finances. Extended rehabilitation would likely benefit patients' rate and extent of recovery but this has not been confirmed in dogs through a controlled clinical trial. Patients return at set intervals (postoperative months 3, 6, and 12, then annually thereafter) for measurements of limb girth, PROM, posture, function, and force plate gait analysis. This data serves to document and objectively evaluate patient progress, to guide modification of the home program as needed, and to trouble-shoot for complications.

ANTICIPATED TKR OUTCOMES

Results of the TKR prospective study completed at Gulf Coast Veterinary Specialists indicate the canine course of recovery closely mirrors that of humans. Preoperatively, patients present with end-stage osteoarthritis (OA) and exhibit restricted PROM in response to periarticular fibrosis and bony changes. Immediately postoperatively, PROM is improved. By 3 months, it is restored to an average excursion of greater than 114°, adequate for all functional activities. Some dogs have continued to increase their PROM over the next 9 months while others exhibit a slight decrease, possibly due to owner cessation of structured exercises.

Significant disuse muscle atrophy is present preoperatively of both the quadriceps and hamstrings. Some dogs are non-weightbearing prior to surgery and present with especially severe atrophy. A further decrease of thigh girth continues for about 6 weeks postoperatively, and then slowly starts to reverse. The rate of girth restoration appears tied largely to consistency of structured exercise completion. To date, full restoration of thigh girth (eg, equal to the contralateral limb) has occurred as early as 7 months postoperatively. Force plate values (peak vertical force and impulse) mirror these trends.

Long term outcomes reveal patients return to high levels of function that provide owner satisfaction. Patients are able to resume running, playing, and community mobility. Clients typically report restored patient ability to posture normally to void (including standing on the surgical leg to hike the nonoperative leg when urinating), safely navigate stairs, and achieve endurance sufficient for quality of life activities.

POSTOPERATIVE RECOVERY FOLLOWING THR

Published studies and commentaries are more readily available for the canine THR. Exuberant activity in the first 8 to 12 weeks post THR has been tied in the literature to increased risk of complications including luxation, propagation of surgically-induced femoral fissures into fractures, and compromised long-term stability of prostheses due to inhibition of bony on-growth or in-growth. Although not yet proven in canines, rehabilitation potentially can mitigate the risk of these complications.

Luxation is the most frequent postoperative complication, occurring in 1.1% to 8.5% of THR cases. Luxation typically occurs in the first 6 postoperative weeks as a spontaneous event or tied to trauma. An excessive angle of lateral opening of the acetabular component increases the risk of luxation by a factor of 8. However, not all prostheses with excessive angles luxate, suggesting soft tissue competency plays a significant role in joint stability through periarticular fibrosis, healing of the joint capsule, and increased muscle strength and support in the first 3 to 4 months postoperatively. Consequently, surgeons routinely prescribe 6 to 8 weeks of activity restriction to walking on surfaces with traction when indoors and on leash when outdoors followed by 4 weeks of progressive leash walks before permitting increased ad lib activity levels. During this time of protection, controlled therapeutic exercise targeting the hip stabilizer muscles in a protected environment, such as in water or on a leash, may increase strength and neuromuscular control more rapidly to protect the joint against luxation, particularly in dogs with marked muscle atrophy preoperatively.

The incidence of femur fractures following total hip replacements has been reported as 2.9% to 4.5%. In one study, over 70% of the fractures were due to trauma, including falls. Although femur fractures can occur at any time, 71% occurred within 4 months, before remodeling of the diaphysis occurred as described by Wolff's Law. The typically recommended 8 to 12 weeks of postoperative restrictions against high-level vigorous activity provide time for cortical bone hypertrophy to occur; this process may take longer in older dogs with chronic OA and bone atrophy. Controlled rehabilitative low impact activities during this time, such as underwater treadmill walking, gentle strengthening, and proprioceptive retraining can help facilitate bone remodeling while improving neuromuscular control and coordination to avoid falls and injury.

SPECIAL CONSIDERATIONS FOR TER

Understanding which implant is used by the surgeon (TATE or Iowa State) allows the therapist to appropriately progress forces during recovery dependent upon the healing tissues. Due to the potential for catastrophic complications (detachment of the medial epicondyle or rupture of the lateral collateral ligament), rehabilitation remains very conservative during the first 6 weeks after surgery. After the 6 week exam, appropriate rehabilitation interventions are provided using the rationale and criteria previously described, extrapolating from those presented for the knee. Special consideration should be added for the dorsal plane of rotation. The TATE radial-ulnar prosthesis is a single component so pronation and supination is lost; rotation is greatly restricted by the Iowa State component. Consequently, patients typically attempt to compensate with shoulder internal and external rotation. Strengthening exercises focusing on the shoulder stabilizers should be added to ensure pain and instability does not develop.

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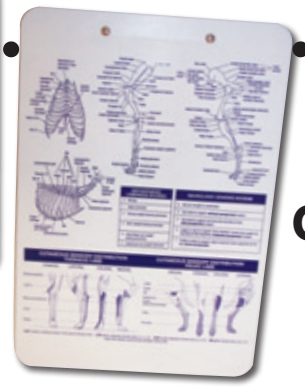
Thank you to Dr. Liska, who provided the details on the surgical approaches for this article.



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